The Fish Communities and Populations of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes, 1981.

Rideau Lakes
Fisheries Assessment Unit
Report No. 10

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Depletion (of fish stocks) is not, as frequently understood a condition either of recent origin or of temporary nature. ... It would be better to consider depletion as a process and to understand how reduction of native stocks begins in the first place in order to appreciate the nature of the final stage... .

.....

This process has been going on (since early travellers and pioneer settlers first arrived)... . It has been assisted by almost every influence that has come about in the course of social and industrial progress. We have only to run through the list - deforestation, navigation facilities, water supply, pollution, power development, tourist trade and what not - to see how the process of fish extermination works.

.....

Viewing the matter historically, we have (in the southwestern portion of the province) ... a relatively small area which ... sustained ... the first shock of industrial development and depletion.

.....

While this development was going on, and during its advanced stages in the last century, the waters immediately along and to the northward of the pre-Cambrian line began to be accessible and also desirable from the summer visitor's point of view.

The waters involved were the Muskoka Lakes, to some extent the Georgian Bay and the magnificent lakes and streams of the Trent and Rideau systems, ... together with the upper reaches of the St. Lawrence River ... . It is the same waters, generally speaking, that are now in critical condition.

.....

Depletion is a process of long duration which can and in all Ontario situations is likely to be greatly accelerated (in the future).

- excerpt from Macdiarmid F., B.A. Bensley and C.A. Candee. 1930. Report of Special Committee on the Game Fish Situation. Legislative Assembly of Ontario Sessional Paper, No. 54. pp. 12-16. Printed and Published by Herbert H. Ball, Printer to the King's Most Excellent Majesty.

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ABSTRACT

In 1981, the Rideau Lakes Fisheries Assessment Unit initiated several long-term programs (index trapnetting, index gillnetting, and lake trout spawning assessment) to monitor the fish communities and populations of five coldwater type lakes. This report documents field procedures and methods of analysis and summarizes the community and population information derived for each lake.

Big Clear Lake - Nine fish species were captured in trapnets at Big Clear Lake: (in descending order of abundance) smallmouth bass, bluegill, largemouth bass, yellow perch, brown bullhead, and lake herring. The ratio of lake herring to lake trout in gillnet catches was 13.2:1.

The growth rate for lake trout was similar to the provincial standard, while mortality rate exceeded recommended levels. Stomach content analysis yielded both fish and crustacea. Spawning assessment showed a substantial run at one shoal only. Spawning depth was 1.0-1.5 m. The mean fork length and weight of spawning lake trout were considerably greater than those of fish caught in the sport fishery.

Smallmouth bass growth rate was similar to that reported for other Ontario populations. The mortality rate for the ages of smallmouth bass harvested in the sport fishery equalled recommended levels.

Big Rideau Lake - Sixteen fish species were captured in trapnets at Big Rideau Lake: (in descending order of abundance) pumpkinseed, bluegill, brown bullhead, rock bass, yellow perch, black crappie, smallmouth bass, northern pike, largemouth bass, white sucker, yellow bullhead, walleye, alewife, lake whitefish, shorthead redhorse, and burbot. The ratio of lake herring to lake trout in gillnets was 2.1:1.

The lake trout population exhibited a low mean age and rapid growth rate. Sculpins and alewife made up the majority of their diet. Spawning assessment showed a substantial run at one shoal only. Spawning depth was 1.0-1.5 m. The mean age, fork length, and weight of spawning lake trout were considerably greater than those of fish caught in the sport fishery.

The growth rate of Big Rideau northern pike was similar to the standard growth curve. Mortality rate approached critical levels. A large percentage of the population was infected with "redsore".

Smallmouth bass growth rate appeared slightly greater than that reported for other Ontario populations. The mortality rate exceeded recommended levels.

Largemouth bass fork length-at-age data provided a good fit with growth models. Estimates of L_∞ appeared realistic.

Big Salmon Lake - Twelve fish species were captured in trapnets at Big Salmon Lake: (in descending order of abundance) bluegill, pumpkinseed, white sucker, rockbass, brown bullhead, largemouth bass, yellow perch, smallmouth bass, lake herring, yellow bullhead, golden shiners, and fallfish. The ratio of lake herring to lake trout in gillnet catches was 3.7:1.

The lake trout population exhibited a low mean age, rapid growth rate, and high mortality. Sculpins made up the majority of their diet. Spawning assessment showed one shoal with a particularly good run. Spawning depth was approximately 1.0 m. The mean age, fork length, and weight of spawning lake trout were considerably greater than those of fish caught in the sport fishery.

The smallmouth bass mortality rate exceeded recommended levels.

Charleston Lake - Fifteen fish species were captured in trapnets at Charleston Lake: (in descending order of abundance) brown bullhead, bluegill, pumpkinseed, yellow perch, rock bass, largemouth bass, yellow bullhead, black crappie, smallmouth bass, northern pike, American eel, alewife, white sucker, golden shiner, and lake trout. The ratio of lake herring to lake trout in gillnet catches was 3.8:1.

The lake trout population exhibited a low mean age, rapid growth rate, and high mortality. Seventy-seven percent of food items in stomach samples were identified as fish. Spawning assessment revealed substantial spawning runs at five shoals. Most spawning occurred at 1.0-2.0 m. American eels were frequently observed on the shoals during spawning. The mean age, fork length, and weight of spawning lake trout were considerably greater than those of fish captured in the sport fishery.

The northern pike growth rate was slightly greater than the Ontario average. Growth parameters estimated from the Walford and von Bertalanffy models compared favourably with the provincial standard.

The mortality rates for both northern pike and smallmouth bass fell well within recommended limits.

Devil Lake - Twelve fish species were captured in in trapnets at Devil Lake: (in descending order of abundance) bluegill, pumkinseed, rock bass, largemouth bass, brown bullhead, black crappie, smallmouth bass, yellow perch, northern pike, yellow bullhead, white sucker, and golden shiner. The ratio of lake herring to lake trout in gillnet catches was 1.3:1.

The lake trout population exhibited a low mean age, rapid growth rate and high mortality. Stomach content analysis revealed that Devil Lake lake trout were primarily piscivorous. Substantial spawning runs were observed at six shoals. Most spawning occurred at 0.5-1.5 m. The mean age, fork length, and weight of spawning lake trout were considerably greater than those of fish caught in the sport fishery.

The growth rate of northern pike was equivalent to the standard growth curve while mortality approached critical levels.

Smallmouth bass growth rate was similar to that reported for other Ontario populations. Mortality exceeded recommended levels.

1. INTRODUCTION

In 1981, the Rideau Lakes Fisheries Assessment Unit (RLFAU) initiated several long-term programs to monitor the fish communities and populations of five coldwater type lakes, ie. Big Clear, Big Rideau, Big Salmon, Charleston, and Devil Lakes (MacLean and Smith 1981a). The program was intended to provide both qualitative and quantitative information for trend-through-time analysis.

In 1981, the overall assessment program included:
1) index trapnetting to monitor the inshore (littoral) fish populations;
2) index gillnetting to monitor the offshore (benthic) fish populations; and
3) a study of lake trout spawning behavior and spawning stock characteristics.

Data collected during these activities were used to determine:
1) species composition and diversity;
2) relative abundance;
3) distributions of age, fork length (FL), and weight;
4) mean FL-at-last-annulus and last increment of growth;
5) Walford and von Bertalanffy growth parameters;
6) instantaneous growth rate;
7) annual mortality rate;
8) lake trout spawning and feeding habits;
9) contribution of stocked lake trout; and
10) occurrence of parasites and disease.

The purpose of this report is to summarize the community and population parameters listed above. While many species are considered, our report deals largely with lake trout, northern pike, smallmouth bass, largemouth bass, and yellow perch.[1]

As this report provides a baseline for future trend-through-time analysis, we have purposely chosen not to compare parameters between lakes and to limit preliminary interpretations.

[1] Common names used throughout this report conform to Bailey et al (1970).

2. THE STUDY AREA

The type lakes included in this study are all situated along the Rideau Corridor (Figure 2.1) in Divisions 9 and 10 of the Ontario Fishery Regulations (Ontario Ministry of Natural Resources (MNR) 1981).

MacLean and Hooper (1981) examined the physical, chemical, and biological characteristics of each lake in detail. Table 2.1 presents an updated summary of this information. The area, mean depth, morphoedaphic index (MEI), and yield estimate for Big Rideau Lake have been recalculated in light of recent contour mapping (Barnes et al. 1984).

The oxygen/temperature regimes of all five lakes are stratified in the summer. Smith and MacLean (1984) reported that Big Clear and Big Salmon Lakes are oligotrophic while Big Rideau, Charleston, and Devil Lakes are mesotrophic.

Table 2.1 Characteristics of the five study lakes (1984 revision).

Lake	Lake Community	Area	Mean Depth	TDS	T/O_2	MEI	Yield	Stresses Fishing	Stresses EAWPI
Big Clear Lake	1804	187.4	20.1	50	SHO	2.5	2.11	030	01000
Big Rideau Lake	3104	5761.0	13.3	138	SHO	10.4	4.02	032	00101
Big Salmon Lake	1804	148.1	13.2	59	SHO	4.5	2.75	020	01000
Charleston Lake	3004	2517.2	17.4	137	SHO	7.9	3.55	031	00111
Devil Lake	2204	1061.5	14.4	109	SLO	7.6	3.48	030	10100

Definition of columns:

Lake Community: First two columns = major community. 18 = lake trout-smallmouth bass; 22 = lake trout-northern pike-smallmouth bass; 30 = lake whitefish-northern pike-smallmouth bass; 31 = lake trout-lake whitefish-northern pike-smallmouth bass-walleye.

Last two columns = minor community. 04 = largemouth bass.

Area= surface in hectares (ha).

Mean depth= mean depth in metres (m).

TDS= total dissolved solids (mg/l) based on the lowest observed summer conductivity (Smith and MacLean 1984). TDS= 0.666 Cond. 25°C (Gale and Goodchild 1982).

T/O_2= temperature/oxygen; ie. SLO = stratified, low oxygen; SHO = stratified, high oxygen.

MEI= metric morphoedaphic index.

Yield= Ryder's annual yield estimate for Northern Great Lakes-St. Lawrence watershed (in kg/ha) (MNR 1982).

Stresses= Fishing: first column = no exploitation, second column = sport exploitation and third column = commercial exploitation; where 0 = non, 1 = low, 2 = medium and 3 = high.

Other: presence = 1 or absence = 0, of E = eutrophication, A = acidification, W = water levels, P = physical alterations and I = introductions. (Note: here introductions refer to exotic species. Various game fish have been successfully introduced to these waters in the past. All five lakes are presently stocked with lake trout.

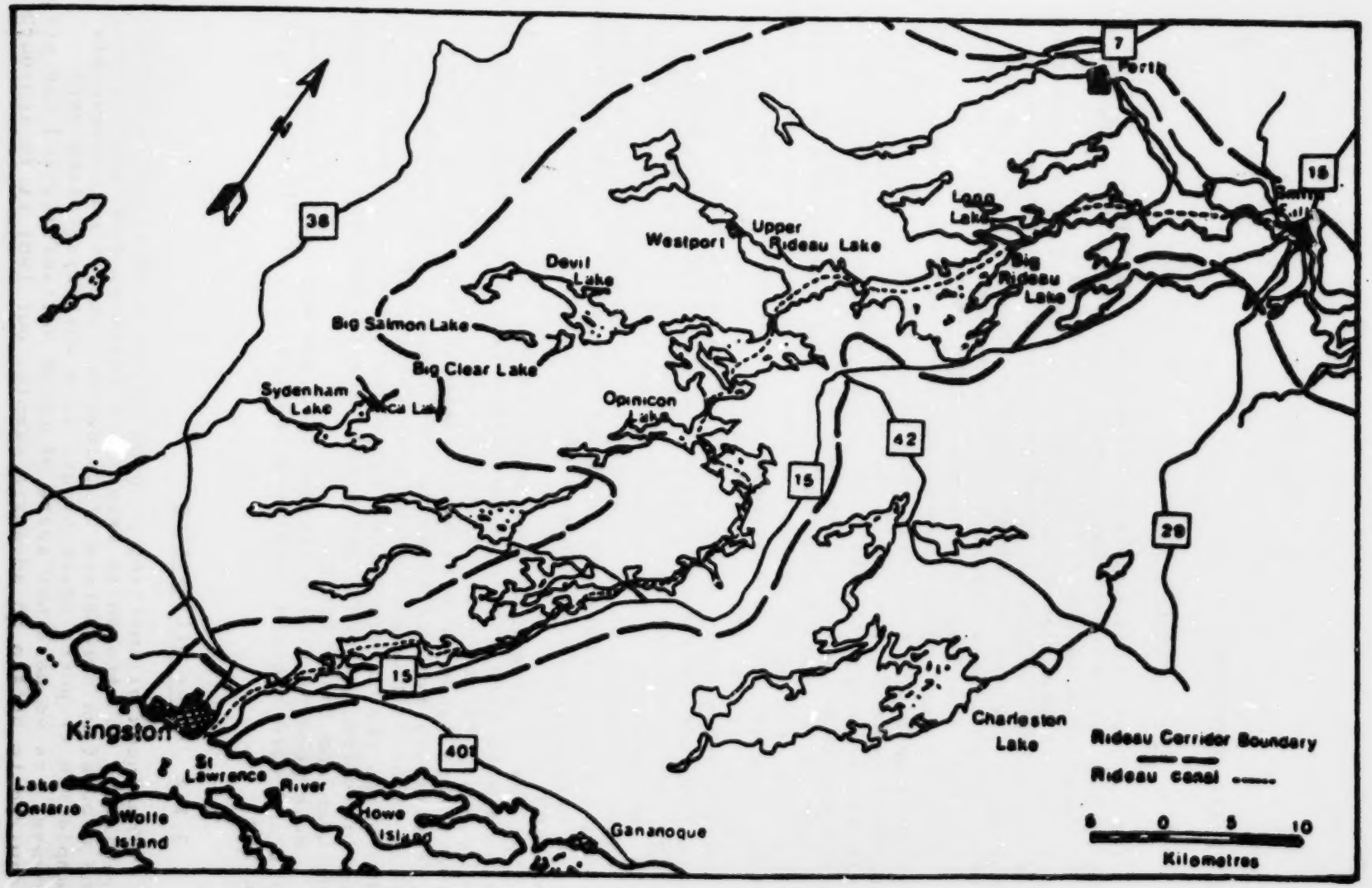


Figure 2.1 Location of the Rideau Corridor and the 10 RLFAU type lakes.

3. METHODS

3.1 FIELD PROCEDURES

3.1.1 Index trapnetting

The trapnetting schedule allowed a 10-day sampling period on each of Big Rideau (6-15 May), Charleston (20-29 May), Devil (3-12 June), Big Salmon (17-26 June), and Big Clear (1-10 July) Lakes. Six trapnets were fished at each lake. Trapnet locations were not chosen on the basis of biological criteria alone. All lakes had a limited amount of littoral area where depths and bottom contours made trapnetting feasible and netting locations were spaced as widely as possible within these areas.

Two sizes of trapnets were used; nets with a 1.8-m box (38-mm stretched mesh, 33.5-m lead), and nets with a 2.3-m box (44-mm stretched mesh, 54.9-m lead). All nets were set overnight and soaktimes were approximately 24 hours. With the exception of Charleston Lake, the trapnetting schedule resulted in 54 lifts per lake (nine lifts X six locations). On Charleston Lake, the field crew arrived on 27 May to find one trapnet stolen and three others slashed. The damaged nets were repaired and reset, allowing 48 lifts (for calculation purposes on Charleston Lake).

During every lift, major game species (lake trout, lake whitefish, northern pike, smallmouth bass, largemouth bass, yellow perch, and walleye) were transferred to a holding cage for detailed sampling, while other species were simply counted and released. However, in the lower basin of Big Rideau Lake (Lower Rideau), where a commercial hoopnet fishery is located, bluegill, black crappie, and pumpkinseed were also kept for detailed sampling.

All major game fish were measured for fork length. Two methods were used (one of them inadvertantly) to sample the catch for age and weight (see Section 3.2.2). Scales of soft-rayed fishes were taken from below the anterior edge of the dorsal fin, approximately two scales above the lateral line. Scales of spiny-rayed fishes were taken near the tip of the left pectoral fin, below the lateral line. Individual fish were examined also for fin-clips, external parasites, and disease and then released (MacLean and Smith 1981b).

Nets were partially cleaned of algae and debris after every lift and were cleaned completely following every 10-day sampling period.

3.1.2 Index gillnetting

The index gillnetting program on the five study lakes was originally undertaken to assess the relative abundance, diversity and population parameters of coldwater species not adequately sampled in trapnets (lake trout, lake whitefish, lake herring). However, as we were not aware of catch variability and the effort required to obtain an adequate sample, our 1981 field approach

was largely experimental. As such, with a preliminary target of 10 lake trout, gillnetting was conducted for a variable number of sampling days on Big Clear (6,7 July), Big Salmon (22,23 July), Devil (30 July), Big Rideau (6,7,11,12), and Charleston (13 August) Lakes.

Netting locations were chosen where water was deep enough to have suitable temperature and oxygen levels for the target species. Temperature and dissolved oxygen were measured using a Hydrolab 8000. Depth was recorded using a Furuno sounder (RLFAU file data).

A standard gillnet set consisted of four net gangs. Each gang was 122-m long, 1.8-m deep, and contained eight randomly strung 15.2-m sections of stretched mesh ranging in size from 38 to 127 mm. Nets were set approximately parallel to the shoreline, on the bottom, in depths ranging from 8 to 23 m. All sets were overnight. Soaktimes ranged from 10.6 to 15.2 hours.

The entire gillnet catch was removed from the nets and taken to the RLFAU laboratory facilities for processing. All species were sampled for age, fork length, total length (TL), and weight. Fish were also examined for fin-clips, parasites, disease, sex, stage of maturity (Kesteven 1960), and restricted gonads (lake trout and lake whitefish only) (MacLean and Smith 1981b).

3.1.3 Lake trout spawning assessment

The lake trout spawning run was monitored on all five lakes during the period 13 October - 3 November. Potential lake trout spawning shoals, identified previously, were patrolled at night using an electric outboard motor and underwater lights.

On various occasions, small mesh gillnets were set on the shoals in order to corroborate visual observations and collect biological data. Entangled by their teeth, lake trout were carefully removed from the net and were sampled for scale age, FL, total length, and weight. Lake trout were also examined for fin-clips, parasites, disease, sex, and maturity (ripe, spawning or spent). After processing, fish were fin-punched (by spawning shoal location) and released (MacLean 1980).

3.2 DATA ANALYSIS

3.2.1 A caution regarding index netting data interpretation

Aside from total removal, no fish sampling method is completely non-selective. Gillnets are often highly selective for certain size classes and behaviours of fish and in the absence of an accurate selectivity curve, the community and population parameters derived from gillnet data can be very biased (Hamley 1975; Pope et al 1975).

As mentioned previously, index gillnetting was originally undertaken to assess the relative abundance, diversity, and population parameters of coldwater species not adequately sampled

in trapnets. Few target species, however, were caught in gillnets. We decided to curtail our sampling rather than remove (or appear to remove) large quantities of fish from these recreational lakes. (Moreover, recent evidence suggests that even large gillnet samples are of little value in assessing relative abundance due to the variability in catches (Craig and Fletcher 1982).

For these reasons, very little gillnet data is presented in this report, although it is available in RLFAU files. (Lake trout population parameters were derived from 1981 creel census data (MacLean and Schlesinger 1982)).

Selectivity of trapnets is a subject that has received considerably less attention. Nevertheless, trapnets too, can be both species and size-selective. Laarman and Ryckman (1982) and Latta (1959) have demonstrated that for many species (including yellow and brown bullhead, bluegill, pumpkinseed, rock bass, black crappie, yellow perch, and walleye), larger fish are easier to catch than smaller fish. As such, Latta (1959) suggested that mortality estimates, calculated from the decrease in numbers of fish in successive age groups, be adjusted using mark-recapture data. Neither study was able to show significant size-selectivity for smallmouth or largemouth bass. On the other hand, Ricker (1975) states that bias in catch-curve survival estimates resulting from size-specific vulnerability, seems unlikely to be large among the older fish in a sample.

Both gillnet and trapnet catches are also influenced by a combination of habitat, behavioral, and environmental factors. Therefore, index netting data collected at different times, from different lakes are not easily compared. Nevertheless, if in future years, nets are fished at the same time of year in each lake and environmental conditions have not changed greatly, then within-lake results should be suitable for trend-through-time analysis.

Other biases that could affect data interpretation are discussed separately below.

3.2.2 Community structure

Species composition (by number), diversity and catch-per-unit-effort (CUE) data were all used to examine community structure.

Species composition and diversity - Diversity of each fish community, based on all species captured, was calculated using the Shannon index of general diversity (H), where :

$$H = -\sum (ni/N) \log_2 (ni/N) \quad \text{and}$$

ni = number of individuals of species i;
N = total catch of all species
(Margalef 1968).

This index reflects both the degree of concentration of dominance in one or a few species (slope) and the number of species (richness). In general, steepness of slope tends to be

The relative abundance of herring and lake trout in gillnet catches was also examined. MNR (1984) has found this ratio a useful indicator when modelling lake trout-lake whitefish -smallmouth bass community exploitation.

3.2.3 Population parameters

Age, fork length, and weight - Frequency distributions of age, FL, and weight have been plotted for all major sport species. Lake trout distributions were calculated from winter and summer creel data. Distributions for all other species were calculated from trapnet data.

Ageing - Recently, the scale method of age determination has come under considerable scrutiny, especially for slow-growing, coldwater species such as lake trout (Healey 1978; MNR 1983). As the scale method was used to age all sampled fish in this study, further comment is appropriate at this point.'

Verification of lake trout scale ages using other calcified structures has shown that, depending to some extent on growth rate, the scale method is inconsistent for lake trout of Ages 6 to 10 and unreliable for older fish. The scale method, however, is more reliable for heavily exploited populations, which usually contain a large number of young individuals that are growing rapidly due to growth compensation (MNR 1983).

Recent investigations using fin rays and otiliths indicate that lake trout in the Rideau Lakes area are the fastest growing in Ontario from Ages 1 to 10 (A. Palilionis, J. Casselman, personal communication; RLFAU data). This can probably be attributed in part to intense exploitation. After Age 10, growth slows considerably and ageing by scale annuli becomes increasingly unreliable. Neverthess, scale-determined ages of almost all sampled hatchery origin lake trout of Age 10 or less were in agreement with ages determined from fin clip information. Thus, although age structure data in this report should be treated with some caution, it is probably quite reliable to Age 10 (MacLean et al. 1985).

Subsampling for age and weight - We had originally planned to measure FL of all fish, but to take scale samples for ageing and weight measurements from a subsample of not more than 10 fish per species in each FL class at each lake. We then intended to expand the age and weight data based on 1) the distributions of scale age and weight within each FL subsample; and 2) the total number of fish collected in each FL class . The mean age, FL, and weight would then be estimated from this grouped data. However, this methodology was put into practice only for the last four lakes in the trapnetting schedule (Charleston, Devil, Big Salmon, and Big Clear Lakes).

'Scales were aged using a Realist Vantage microfiche reader. Lake trout were aged using 68x magnification; all other species at 33x.

inversely related to richness.

In addition, species composition and diversity were used to determine the homogeneity between index trapnetting sites. The percent similiarity between the catch at different netting sites was first calculated (based on the catch of the six most abundant species); then cluster analysis used to group locations. Haedrich (1975) proposed the use of these two indices as a measure of environmental quality. Hopefully, their use here will allow us to detect any fish community changes at a finer level.

Percent similarity (PS) was calculated as:

$$PS = 100(1.0 - 0.5 \leq(Abs(pia - pib)))$$

where pia = number of individuals in the ith species at location "a" divided by the total number of individuals at location a; pib = the same for location b and Abs = absolute value.

Principal component analysis (PCA), based on percentages of the six most abundant species (pia above), was used as an additional method to identify netting locations with similar community structure and to determine the relationships among the species defining that structure (Nichols 1977; Sprules 1977; Green 1979). Tonn and Magnuson (1983) have recently suggested that this type of multivariate analysis will be useful in developing fisheries management strategies on a community basis.

Each component calculated in PCA describes a contrast in the relative abundance of the species sampled and the importance of that contrast in explaining the variation observed among the trapnet sites. The first component defines the greatest amount and each succeeding one a lesser aspect of the variation among the locations. The absolute values assigned to each species, within a component, provide a linear scale which is used to assess their contribution to the variation described by a particular component. The larger the value, the greater the contribution. The signs, (+) or (-) of the values, describe the contrast between the species at each location.

Preliminary analysis of the percentage data indicated that the variance increased with increasing mean values. To reduce the possibility of a single dominant species obscuring the community relationships among the net sites (Nichols 1977), a $\sqrt{Y+1/2}$ transformation was appled to the percentage data, where Y is the species' percentage (pia) described above. This transformation is recommended by Steel and Torrie (1980) when some of the values are less than 15% and zeros are present. The variance-covariance matrix of the transformed percentages was used to derive the principal components.

Relative abundance - CUE values from trapnets, expressed as the number of fish caught per lift, were considered a measure of the relative abundance of littoral zone fishes, whereas gillnet CUE's measured the abundance of the offshore limnetic community. For the purpose of discussion, the species with the greatest CUE was considered to be numerically dominant. Other species with CUE values greater than 20% of the CUE of the dominant species were considered "moderately abundant". Species with CUEs less than 20% of the dominant species were deemed "relatively uncommon".

For all target species on Big Rideau Lake and for yellow perch on Charleston Lake, the field crew correctly subsampled up to 10 fish in each FL class, but then mistakenly released all subsequent fish without recording FL. Hence, frequency distributions of age, FL, and weight could not be determined using stratified subsampling. Alternatively, frequency distributions were generated from the sample of fish that were processed prior to the very first fish being released without processing. This procedure is equivalent to having taken a small random sample and should result in reasonably accurate distributions.

Growth - Estimating growth rates of fish is difficult because of the common occurence of size selective natural and/or fishing mortality and sampling bias (Ricker 1969). As a means of overcoming some of the above difficulties, growth was assessed using three different methods, instantaneous growth rates, fork length-at-age, and the Walford and von Bertalanffy growth models.

The instantaneous growth rate of each population was calculated as the slope of the least squares regression line of the natural logarithm (ln) of the mean fork length-at-age against age using the appropriate exponential growth phase.

Only fish captured at, or close to a period of growth cessation were used for growth assessment (lake trout from the winter sport fishery, all other species from spring-early summer trapnetting). As a result, an annulus was credited at the edge of the scale for ageing purposes and backcalculations were not necessary. Of the species sampled, growth standards have been determined only for lake trout and northern pike. Growth indices, the fork length expressed as a percent of the growth standard, were used as a measure of the deviation in a data set from the growth standard established for lake trout and northern pike (MNR 1983). Growth rates were described as similar to the above standards if they deviated from them by less than 10%, slightly greater or lesser if they deviated by 10-20%, and much greater or lesser if they deviated by >20%.

Growth parameters estimated from Walford and von Bertalanffy growth models (Ricker 1975), in addition to (Galucci and Quinn 1979) were calculated for lake trout, northern pike, smallmouth bass, and largemouth bass (MNR 1983).

Note: von Bertalanffy estimates were not attempted unless the correlation coefficient from the Walford plot was >= 0.90. These estimates used to calculate ω' ($k \times L_\infty$), were determined based on a linear regression, and not from a non-linear procedure as recommended by Galucci and Quinn (1979). This was in part the result of the available in house statistical procedures; however, the high R values (>0.90) indicate that a non-linear procedure would not have provided a significantly improved fit of the data.

Walford estimates are susceptible to numerous sources of error, including: 1) gear selectivity for larger size among younger fish; 2) underageing of older fish; 3) imprecise fork length-at-age estimates related to sample size; 4) non-

representative sampling including only a narrow range of age groups with an increasing growth rate; and 5) inaccurate mean length-at-age estimates due to different growth rates for hatchery and native lake trout.

Mortality - Total annual mortality rates were calculated by constructing catch curves from age frequency data (Ricker 1975). Mortality of lake trout populations were derived from winter and summer creel census data. Mortality rates for other species were derived from trapnet data.

Parasites and diseases - For major sport fish species caught in trapnets, the percentage occurrence of common external parasites and disease was determined, ie. blackspot Neascus sp.; redsore; yellow grub Clinostomum marginatum; and fish lice Ergasilus or Salmincola sp..

Lake trout spawning- The fork length, weight, and age distributions of the spawning stock as well as sex ratios and percent occurence of hatchery origin fish were determined from fall spawning assessments.

Lake trout food habits - The percentage composition (by number) of certain food items in lake trout stomach contents was determined from samples collected during gillnetting.

4. RESULTS AND DISCUSSION

4.1 BIG CLEAR LAKE

4.1.1 Community structure

Species composition and diversity - Smallmouth bass (37.5%) comprised the greatest percentage of the catch, followed by pumpkinseed (18.6%), bluegill (17.3%), largemouth bass (11.6%), yellow perch (5.6%), white sucker (4.1%), yellow bullhead (3.6%), brown bullhead (1.6%), and lake herring (<0.1%). Most of the fish were caught at trapnet site 1 (Table 4.1, Fig. 4.1).

The relative abundance of fishes in the littoral zone generally parallels the species composition data presented above. In early July, the littoral zone was dominated by smallmouth bass. Pumpkinseed, bluegill, and largemouth bass were moderately abundant. Lake herring, white sucker, yellow bullhead, brown bullhead, and yellow perch were present but relatively uncommon (Table 4.2).

Lake herring, rare in the trapnets, was the most abundant species in gillnet catches. The ratio of lake herring to lake trout was 13.2:1 (Table 4.2, Fig. 4.1) (Note: The large number of warmwater species represented in these catches is in part due to the extremely irregular bottom with numerous shoal areas).

The overall Shannon diversity index was 2.48 and ranged from 1.86 (Site 5) to 2.32 (Site 4) for individual trapnet locations (Fig. 4.1).

With respect to species composition, trapnet 4, located at the mouth of the inflow from Black Lake had the lowest percentage similarity, while the remaining five locations were very similar (Fig. 4.2).

The dissimilarity of site 4 was the result of its higher proportional abundance of largemouth bass and yellow perch but lower percentage of smallmouth bass than the other five sites (1, 2, 5, 6, and 7) (Fig. 4.3, Table 4.1) and accounted for 75% of the total variation among the trapnet sites (Table 4.3).

Most of the remaining variation (13%) among the trapnet locations was explained by the differences in relative bluegill abundance at sites 1, 2, 5, 6, and 7 (Table 4.3). The proportional abundance of bluegill ranged from a high at site 1 (31.3%) to a low at site 5 (4.9%). Sites 2 (16.9%), 6 (16.7%), and 7 (17.8%) were intermediate with respect to bluegill abundance (Fig. 4.3, Table 4.1).

4.1.2 Population characteristics

Lake trout - Lake trout age, fork length and weight distributions from the 1981 winter and summer sport fisheries are depicted in Figures 4.4 - 4.9. Mean values with 95% confidence limits are shown below.

Sample	Age (yr)	Total Length (cm)	Fork Length (cm)	Weight (g)
Winter				
hatchery	4.9 ± 0.7	33.4 ± 3.9	30.5 ± 3.6	333 ± 192
native	6.5 ± 0.4	43.7 ± 3.6	39.9 ± 3.4	829 ± 287
all	5.9 ± 0.4	40.0 ± 3.0	36.5 ± 2.8	652 ± 207
Summer				
hatchery	7.3 ± 5.7	51.2 ± 35.7	46.5 ± 33.1	1274 ± 3093
native	6.8 ± 2.0	52.6 ± 22.3	48.2 ± 21.2	1488 ± 1605
all	7.0 ± 1.5	47.6 ± 4.8	43.8 ± 4.5	1297 ± 942

Ages in the winter sport fishery ranged from 3-10 years with the 1975 (age 6) year class the most abundant (Fig. 4.4). Ages in the summer sport fishery ranged from 5-10 with the 1974 and 1975 (ages 6 and 7) year classes the most abundant (Fig. 4.7).

Thirty-six percent of the lake trout sampled during the winter fishery and 43% of those sampled during the summer were of hatchery origin.

The growth rate of lake trout in Big Clear Lake was similar to that expected for Ontario populations. The growth index for the most abundant year class, age 6, was slightly lower than the provincial standard (85%), while the index for all ages was equal to the standard (100%) (MNR 1983) (Table 4.4). The instantaneous growth rate for lake trout was 0.186 + 0.027 based on ages 4-10 (Fig. 4.10). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.5).

The total mortality rate was 0.53 for lake trout sampled during the winter creel census based on ages 6-10 (Table 4.6). This slightly exceeds the critical level of 0.50 for lake trout (MNR 1983).

Parasitic evaluations, based on a qualitative analysis from summer creel, gillnets, and spawning assessments, indicate that, externally, Salmincola, and internally, intestinal tapeworms, commonly affect lake trout living in Big Clear Lake. Occurrences of fin rot, gill and intestinal flukes, popeye (Diplostomatidae), and leech parasitism were incidental.

Lake trout in Big Clear Lake appear to be primarily piscivorous. Stomach contents from nine lake trout were examined. Sixty-four percent of the food items were identified as fish products, ie. 36% were herring and 27% were identifiable only as fish matter. Oppossum shrimp Mysis aculata relicta, made up the remaining 36% of the stomach contents. One stomach was empty.

Lake trout were observed at four of the six known spawning locations in Big Clear, however a substantial run was only noted at one location (Table 4.7). Spawning depth was 1.0-1.5 m. The mean age of three lake trout sampled was 8 years, mean fork length was 76.5 ± 8.2 cm, and mean weight was 5608 ± 1958 g. All three lake trout sampled were native fish.

Smallmouth bass - The mean age of the smallmouth bass

captured in the trapnets was 4.6 ± 0.2 years, mean fork length was 21.8 ± 0.5 cm, and mean weight was 205 ± 16 g. Ages ranged from 3 to 8 years with the 1978 (age 3) year class the most abundant (Fig. 4.11).

The instantaneous growth rate was 0.139 ± 0.029 based on ages 3-8 (Fig. 4.10).

The growth parameters calculated from the Walford (L_∞=46.2 cm, k=0.145) and von Bertalanffy (L_∞= 47.2 cm, k=0.138, t_0=-0.019, and ω'=6.5) analyses appear to be realistic estimates. L_∞ is very close to the maximum length-at-age (45.7 cm) reported from Lake Huron (Scott and Crossman 1973) (Table 4.5, Fig. 4.12).

The total mortality rate for smallmouth bass taken in the trapnets was 0.28 based on ages 3-8 (Table 4.6). Because a second peak in abundance occurred at age 6 (Fig. 4.11), the mortality rate was also calculated for ages 3-5 (0.49) and 6-8 (0.50) (Table 4.6). The mortality rates for ages 3-5 and 6-8 are similar to the critical level (0.50) for smallmouth bass (MNR 1983). Seventy-nine percent of the sport fishery catch was in the age 3-5 interval (MacLean and Schlesinger 1982). Therefore, the mortality rate for the 3-5 year olds is more indicative of the population's response to 1981 effort levels than the overall estimate (ages 3-8).

Table 4.8 summarizes the percent occurrence of visible external parasites for target species sampled during trapnetting. Blackspot and Ergasilus affected more than one-half of the smallmouth bass sampled.

Largemouth bass - The mean age of the largemouth bass caught in the trapnets was 3.4 ± 0.2 years, mean fork length was 24.9 ± 1.3 cm, and mean weight was 391 ± 74 g. Ages ranged from 2-9 years with the 1978 (age 3) year class the most abundant (Fig. 4.13).

The instantaneous growth rate was 0.151 ± 0.049 based on ages 2-9 (Fig. 4.10).

While the von Bertalanffy growth parameter estimates are statistically acceptable, they are also unrealistic (Table 4.5) (Figure 4.12). Scott and Crossman (1973) report the maximum recorded largemouth bass length at 82.7 cm (for a bass caught in Georgia). MacKay (1963) lists the maximum total length-at-age for Ontario largemouth bass as 53.3 cm.

The total mortality rate of the largemouth bass sampled on Big Clear Lake was 0.41 based on ages 3-9 (Table 4.6). Because a second peak in abundance occurred at age 6 (Fig. 4.13), the mortality rate was also calculated for ages 3-5 (0.69) and ages 6-9 (0.38) (Table 4.6). The largemouth bass fishery on Big Clear Lake is small, about 1/5 the smallmouth bass catch. As a result of the small largemouth bass harvest, the age structure of the catch could not be determined from creel sampling in 1981 (MacLean and Schlesinger 1982). Nevertheless, if the 3-5 year interval is the most prevalent in the largemouth as it is in the smallmouth bass fishery, then the high mortality rate should be regarded as a cautionary note with respect to the largemouth bass fishery.

Blackspot was the most common external parasite observed

on largemouth bass during trapnetting (Table 4.8).

Yellow perch - The mean age of the yellow perch taken in the trapnets was 4.3 ± 0.3 years, mean length was 20.3 ± 0.7 cm, and mean weight was 118 ± 14 g. Ages ranged from 2-8 years with the 1977 (age 4) year class the most abundant (Fig. 4.14).

The instantaneous growth rate was 0.083 + 0.009 based on ages 2-8 (Fig. 4.10).

The total mortality rate for yellow perch sampled in the trapnets on Big Clear Lake was 0.44 based on ages 4-8 (Table 4.6).

Yellow grub was the most common external parasite observed on yellow perch during trapnetting (Table 4.8).

Table 4.1 Species composition and total catch at Big Clear Lake during July 1-10, 1981 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN4	TN5	TN6	TN7	All Sites	Total Catch
Lake herring					16.7		<0.1	1
White sucker	1.7	5.2	1.9	7.9	16.7	7.8	4.1	49
Yellow bullhead	6.9	3.9	2.3	1.1			3.6	43
Brown bullhead	2.7		0.8	2.2			1.6	19
Pumpkinseed	17.0	20.8	10.5	24.3	16.7	28.9	18.6	221
Bluegill	31.3	16.9	8.6	4.9	16.7	17.8	17.3	206
Smallmouth bass	39.2	46.8	11.3	55.8	33.3	37.8	37.5	446
Largemouth bass	1.2	6.5	40.2	3.4		7.8	11.6	138
Yellow perch			24.8	0.4			5.6	67
Total catch	406	154	266	267	6	90		1189
Percent catch	34.1	13.0	22.4	22.5	0.5	7.6	100.0	

Table 4.2 CUE for fishes caught at Big Clear Lake during 1981 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Lake trout		5.0
Lake herring	<0.1	66.0
White sucker	0.9	5.0
Yellow bullhead	0.8	
Brown bullhead	0.4	
Pumpkinseed	4.1	1.5
Bluegill	3.8	
Smallmouth bass	8.3	13.5
Largemouth bass	2.6	
Yellow perch	1.2	1.0

[1] total number of trapnet lifts = 54

[2] total number of gillnet lifts = 2

Table 4.3 First two principal components for the six most abundant species captured in trapnets on Big Clear Lake, July 1-10, 1981.

Species	Principal Component	
	1	2
White sucker	0.18	0.35
Pumpkinseed	0.16	0.23
Bluegill	0.15	-0.83
Smallmouth bass	0.41	0.33
Largemouth bass	-0.65	0.16
Yellow perch	-0.58	0.02
Percent variance	75.3	13.2
Cumulative variance	75.3	88.5

Table 4.4 Mean fork length-at-age (cm), 95% confidence limits and growth indices[1] for fishes captured in Big Clear Lake, 1981. Values in parentheses are sample sizes.

Species		Age II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Lake trout	Mean		25.4 ± 1.1	25.5 ± 21.0	28.5 ± 0.9	33.8 ± 1.7	44.1 ± 2.2	54.7 ± 7.2		73.2 ± NA			
	GI		174	92	87	85	97	107		120			100
			(6)	(2)	(11)	(18)	(13)	(5)		(1)			
Smallmouth bass	Mean		16.1 ± 0.4	20.2 ± 0.5	23.6 ± 1.3	26.7 ± 0.6	30.0 ± 1.3	32.8 ± 2.2					
			(49)	(31)	(22)	(52)	(15)	(18)					
Largemouth bass	Mean	16.4 ± 1.0	20.9 ± 1.3	28.0 ± 1.3	30.6 ± 4.5	37.3 ± 2.1	43.8 ± 19.2		45.9 ± 6.6				
		(30)	(57)	(19)	(4)	(7)	(2)		(2)				
Yellow perch	Mean	16.9 ± 0.6	18.3 ± 0.8	19.3 ± 0.9	21.0 ± 1.0	23.3 ± 2.0		27.8 ± NA					
		(2)	(12)	(18)	(13)	(5)		(1)					

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for lake trout (MNR 1983).

Table 4.5 Walford and Von Bertalanffy growth parameters for target species caught in Big Clear Lake, 1981. Blank spaces indicate data which did not fit the Von Bertalanffy model.

Species	Ages	Walford L_{∞} (cm)	Walford K	Walford R^2	Von Bertalanffy L_{∞} (cm)	Von Bertalanffy K	Von Bertalanffy t_0	Von Bertalanffy ω	Von Bertalanffy R^2
Lake trout	3 - 8	19.8	0.408	0.96					
Smallmouth bass	3 - 6	46.2	0.145	0.99	47.2	0.138	-0.019	6.5	0.99
Largemouth bass	2 - 9	109.3	0.064	0.96	109.3	0.059	-0.867	6.4	0.97

[1] $\omega = K \times L_{\infty}$ (Gallucci and Quinn 1979, based on a linear regression of $\ln (L_{\infty} - L_t)$ against age.

Table 4.6 Total mortality rates for target species captured on Big Clear Lake in 1981. Lake trout estimates are from winter creel census, other species from trapnet data.

Species	Mortality Rate	Confidence Interval	Ages
Lake trout	0.53	0.40 - 0.63	6 - 10
Smallmouth bass	0.28	0.00 - 0.50	3 - 8
	0.49	0.00 - 0.98	3 - 5
	0.50	0.00 - 1.00	6 - 8
Largemouth bass	0.41	0.21 - 0.56	3 - 9
	0.69	0.28 - 0.87	3 - 5
	0.38	0.00 - 0.62	6 - 9
Yellow perch	0.44	0.34 - 0.53	4 - 8

Table 4.7 The number of lake trout observed during spawning investigations at 6 shoals on Big Clear Lake, 14 October - 3 November, 1981.
Blank spaces denote missing data due to weather or logistical constraints.

	Shoal					
Date	1	2	3	4	5	6
October 14	0/0	4/0	0/0	3	1	0
October 19	0	0	0	0/2	0	0
October 23	2	0	0	20	0	0
October 26	0	0	0	0	0	0
November 3	0	0	0	0	0	0

#/# denotes 2 observations on same night.

Table 4.8 The percent occurrence of visible external parasites for target species captured during trapnetting in Big Clear Lake, July 1-10, 1981.
Blank spaces denote that no parasite were observed.

Species	No.	Parasite		
		Blackspot	Yellow grub	Ergasilus
Smallmouth bass	192	68	8	59
Largemouth bass	125	86	28	42
Yellow perch	53	43	60	

Figure 4.1 Index netting gear locations on Big Clear Lake, 1981.

● = trapnet location.
⊢—⊣ = gillnet location.

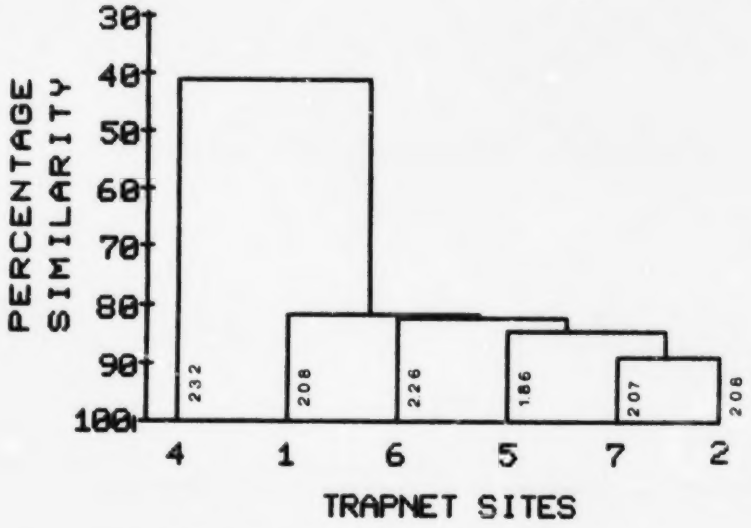


Figure 4.2 The percentage similarity between the trapnet sites on Big Clear Lake, July 1-10, 1981. The number next to each cluster is the diversity index for the respective sites.

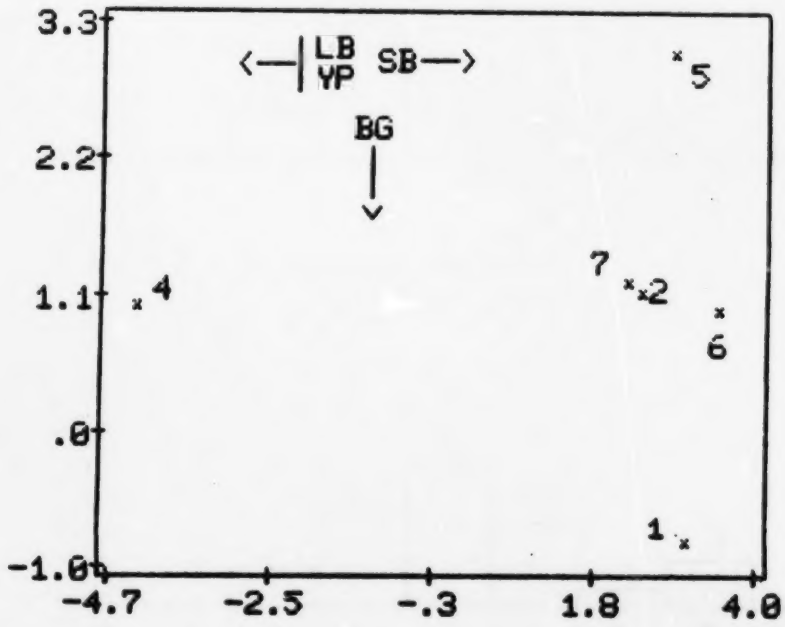


Figure 4.3 The major differences in species composition between the Big Clear Lake trapnet sites, July 1-10, 1981. With respect to each axis (principal component), the arrows indicate the direction of increasing proportional abundance of the designated species.
LB, largemouth bass; YP, yellow perch; SB, smallmouth bass; BG, bluegill

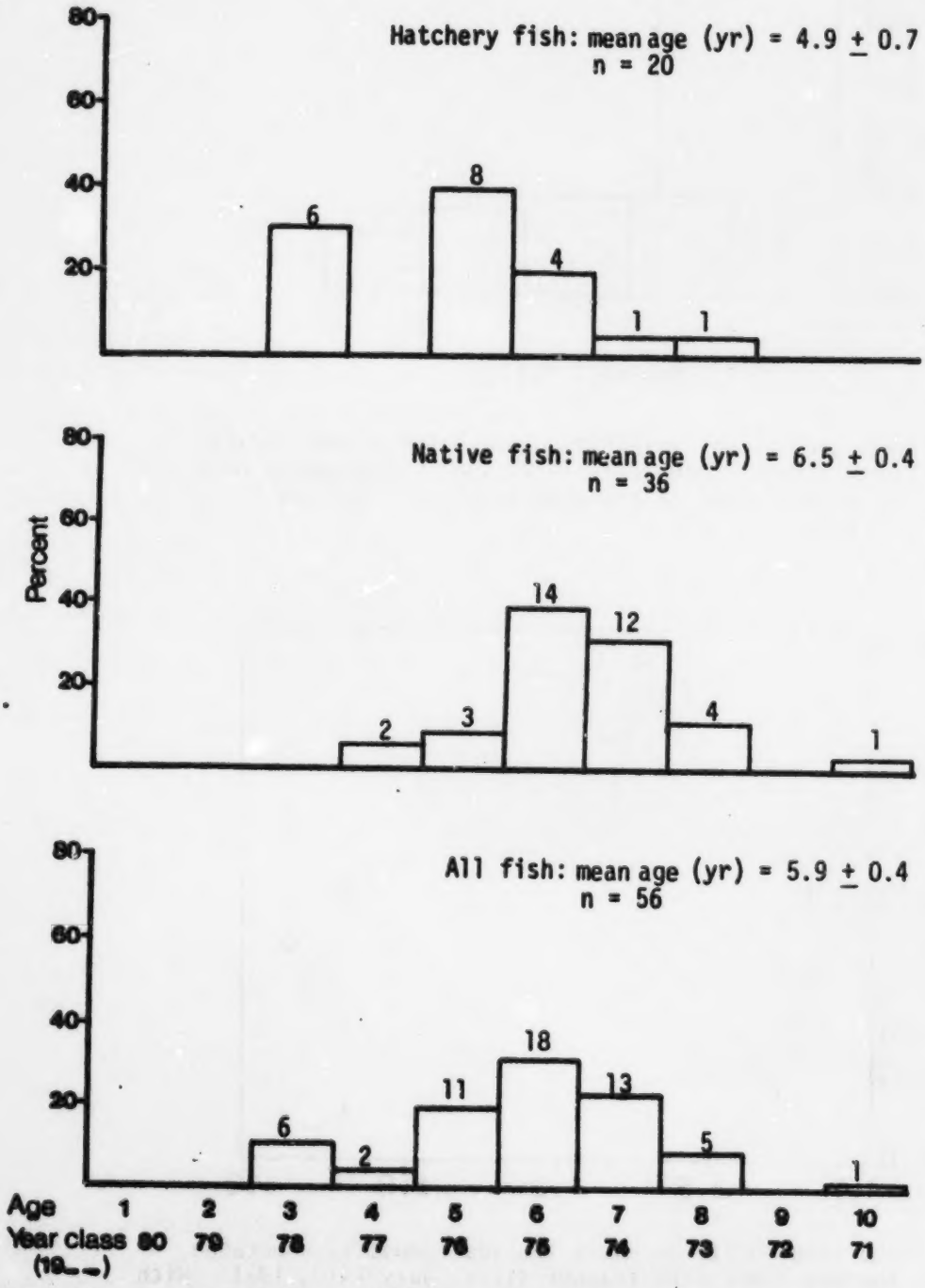


Figure 4.4 Age distributions of lake trout sampled during the winter 1981 sport fishery on Big Clear Lake.
Numbers over each bar indicate actual count frequencies.

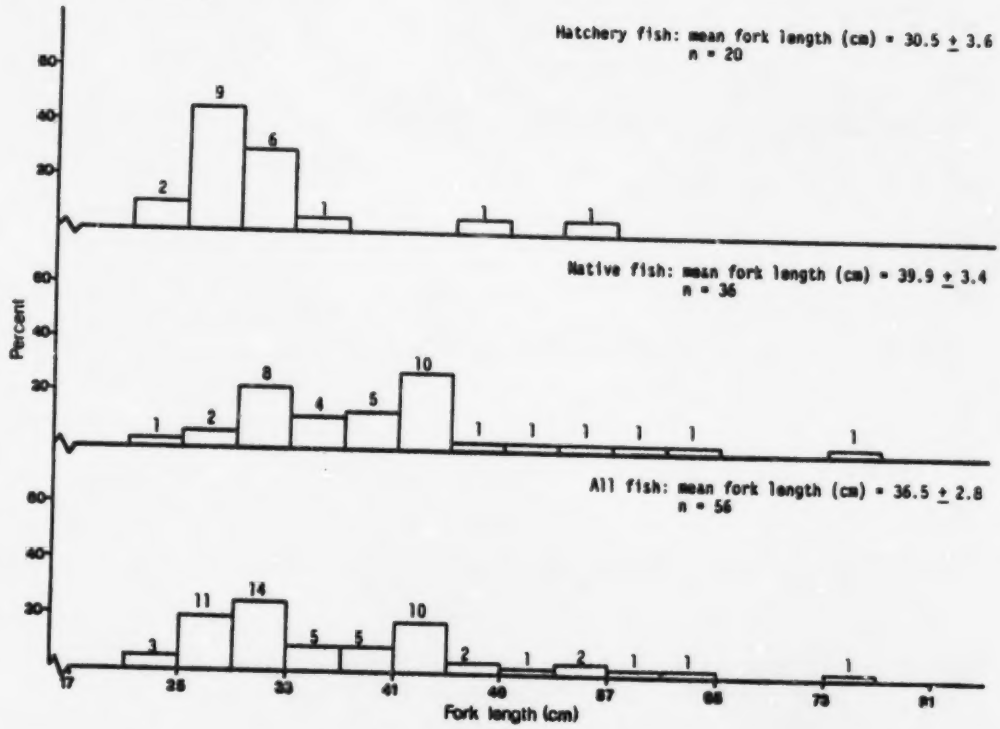

Hatchery fish: mean fork length (cm) = 30.5 ± 3.6
n = 20
Native fish: mean fork length (cm) = 39.9 ± 3.4
n = 36
All fish: mean fork length (cm) = 36.5 ± 2.8
n = 56
Percent
Fork length (cm)

Figure 4.5 Fork length distributions of lake trout sampled during the winter 1981 sport fishery on Big Clear Lake. Numbers over each bar indicate actual count frequencies.

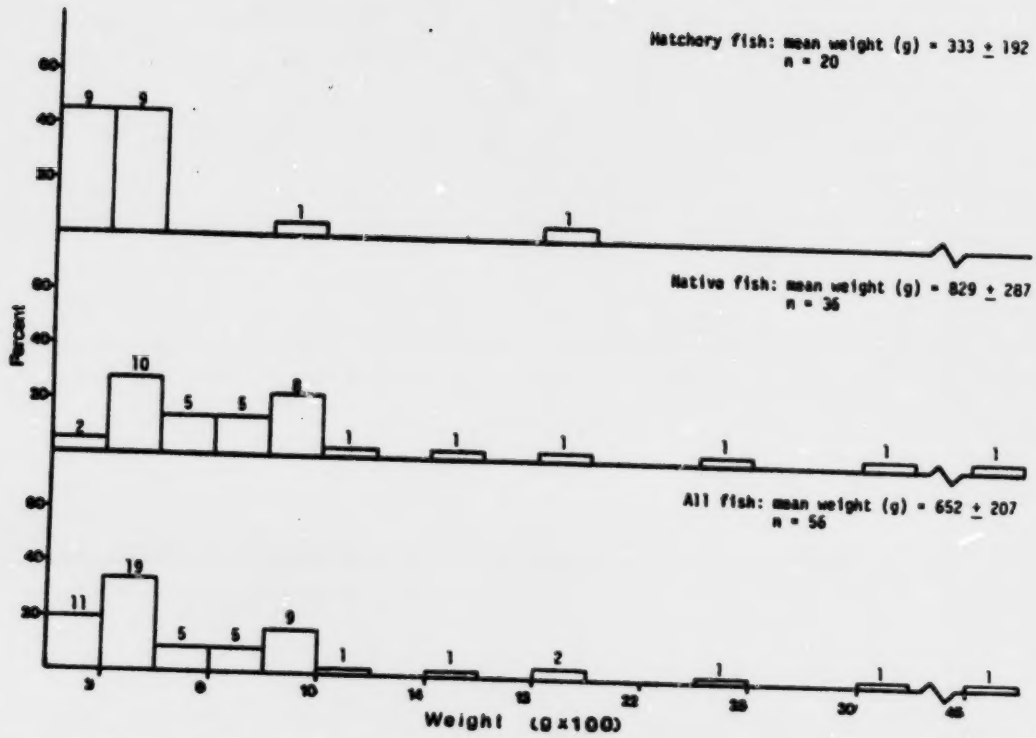

Hatchery fish: mean weight (g) = 333 ± 192
n = 20
Native fish: mean weight (g) = 829 ± 287
n = 36
All fish: mean weight (g) = 652 ± 207
n = 56
Percent
Weight (g x100)

Figure 4.6 Weight distributions of lake trout sampled during the winter 1981 sport fishery on Big Clear Lake. Numbers over each bar indicate actual count frequencies.

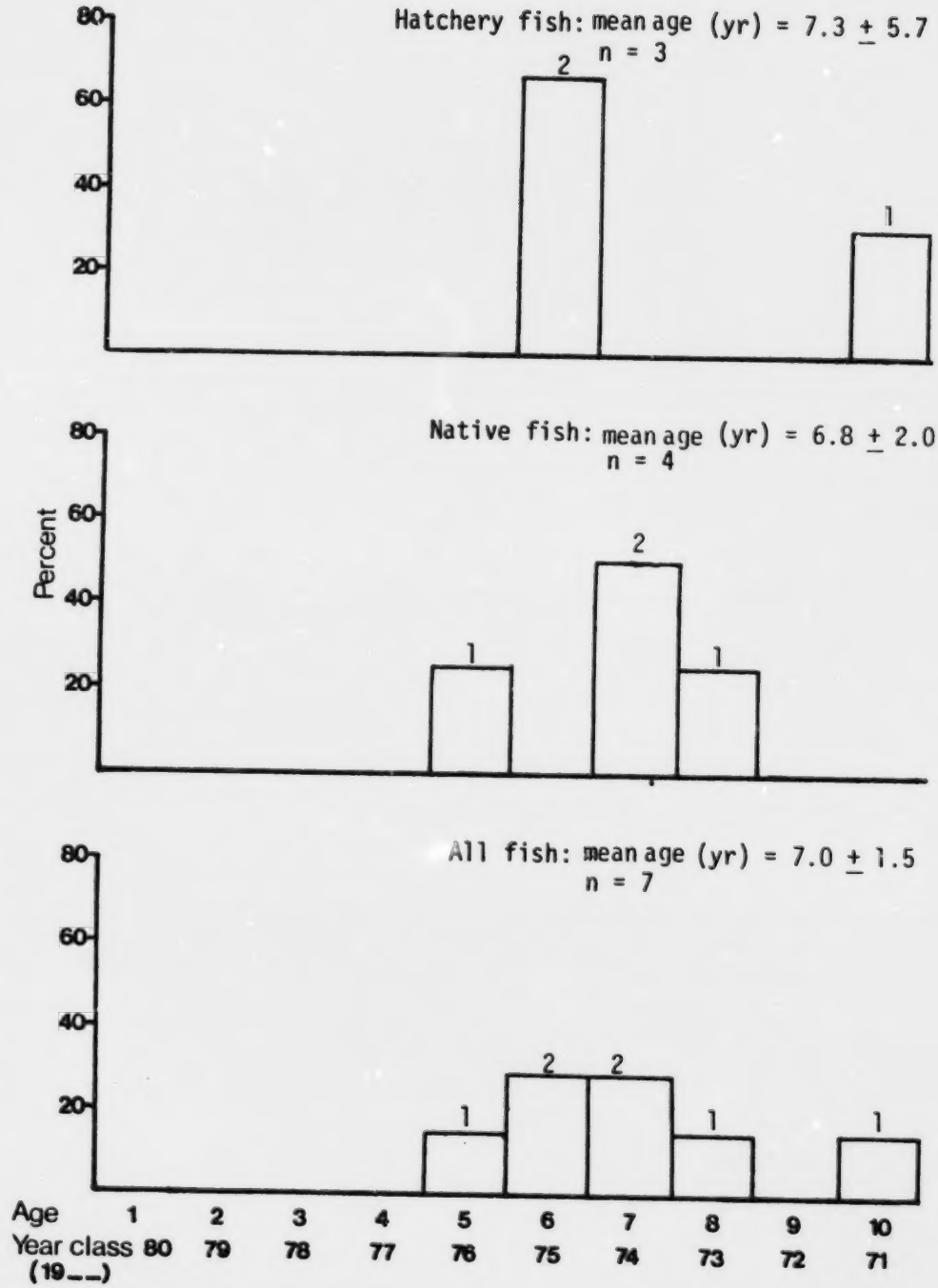

Hatchery fish: mean age (yr) = 7.3 ± 5.7
n = 3
Native fish: mean age (yr) = 6.8 ± 2.0
n = 4
All fish: mean age (yr) = 7.0 ± 1.5
n = 7
Percent
80
60
40
20
Age 1 2 3 4 5 6 7 8 9 10
Year class (19__) 80 79 78 77 76 75 74 73 72 71

Figure 4.7 Age distributions of lake trout sampled during the summer 1981 sport fishery on Big Clear Lake.
Numbers over each bar indicate actual count frequencies.

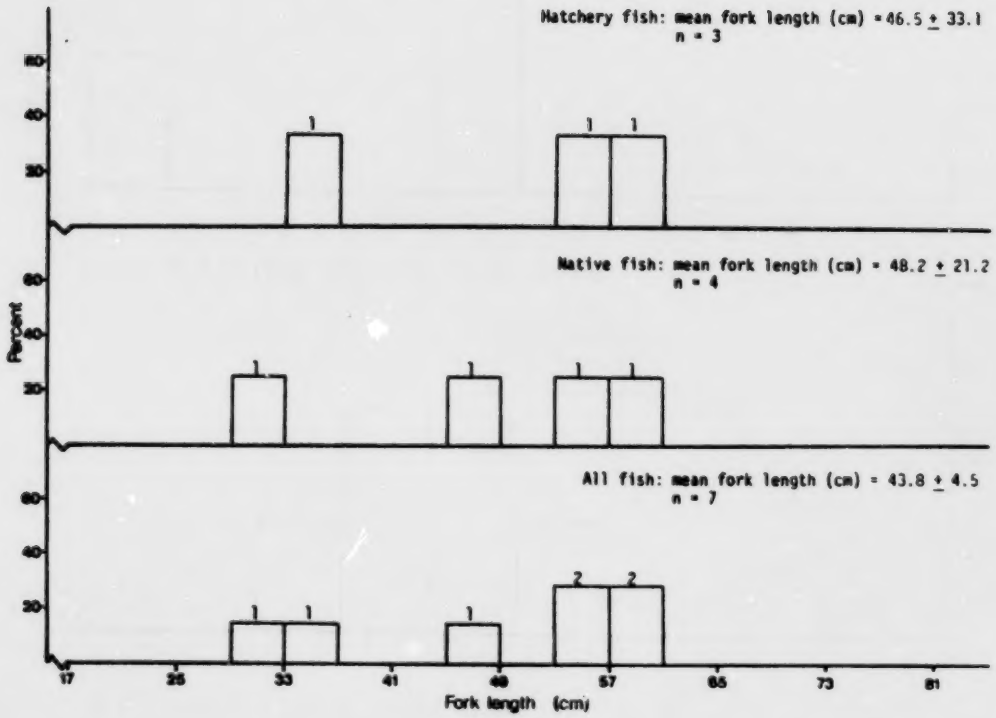


Figure 4.8 Fork length distributions of lake trout sampled during the summer 1981 sport fishery on Big Clear Lake. Numbers over each bar indicate actual count frequencies.

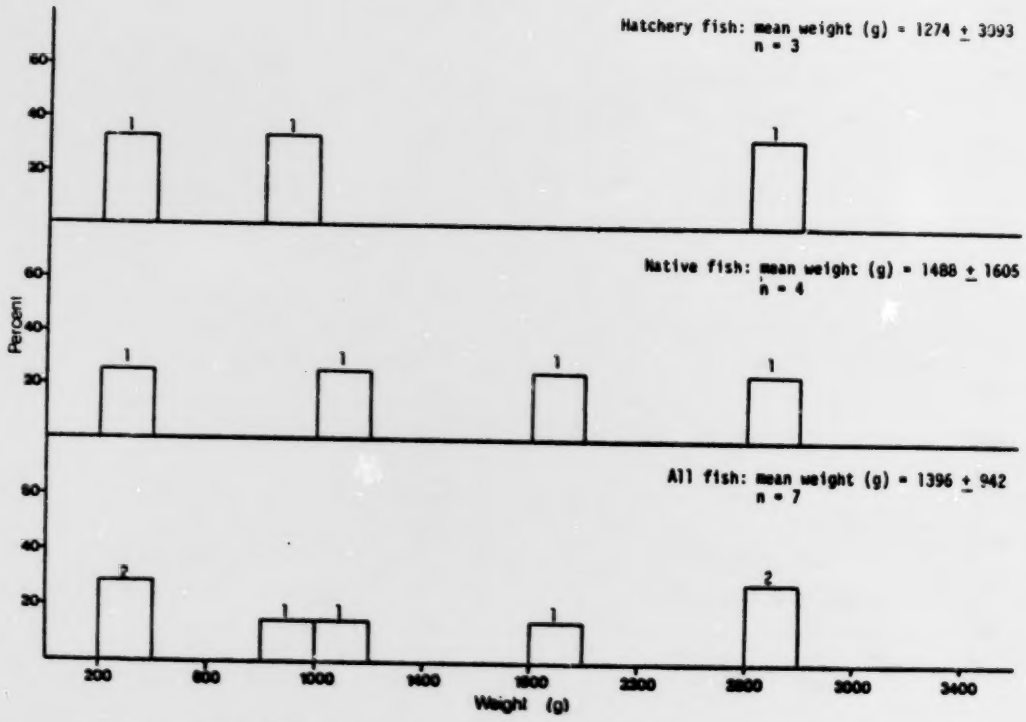


Figure 4.9 Weight distribution of smallmouth bass sampled during the summer of 1981 fishery on Big Clear Lake.
Numbers over each bar indicate actual count frequencies.

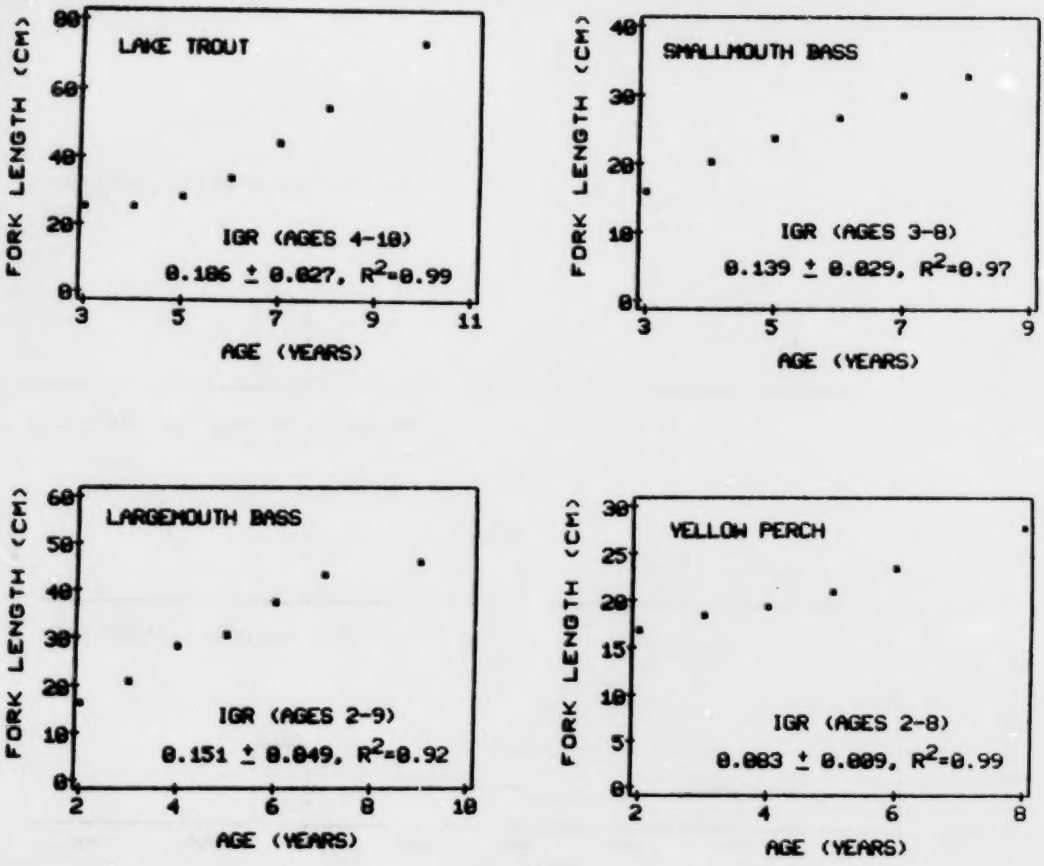


Figure 4.10 Absolute growth rate of lake trout, smallmouth bass, largemouth bass, and yellow perch sampled at Big Clear Lake, 1981. Lake trout were sampled during the winter 1981 creel census. The other target species were sampled during the index trapnetting, July 1-10, 1981. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

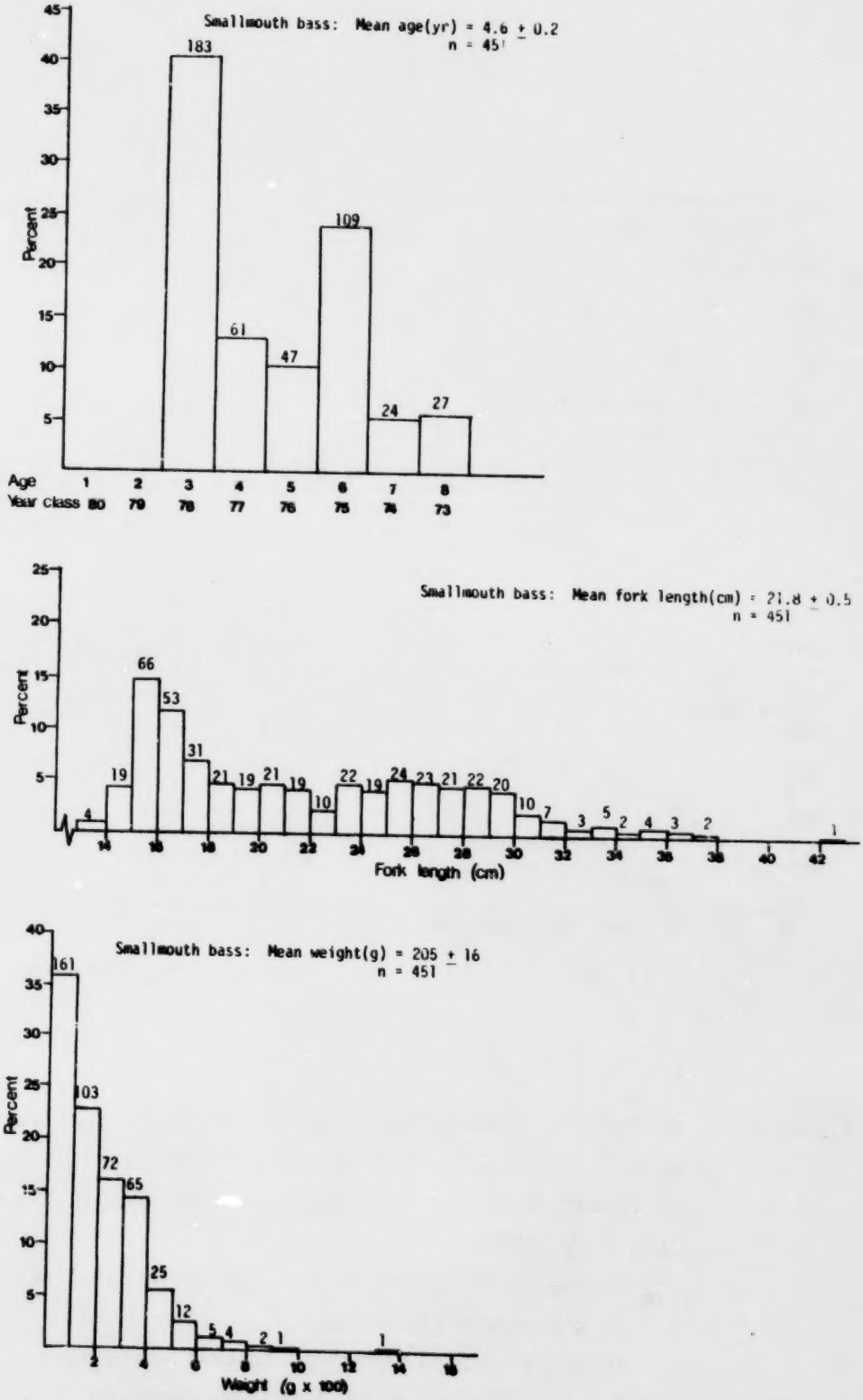


Figure 4.11 Age, fork length, and weight distributions of smallmouth bass captured in trapnets on Big Clear Lake, July 1-10, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

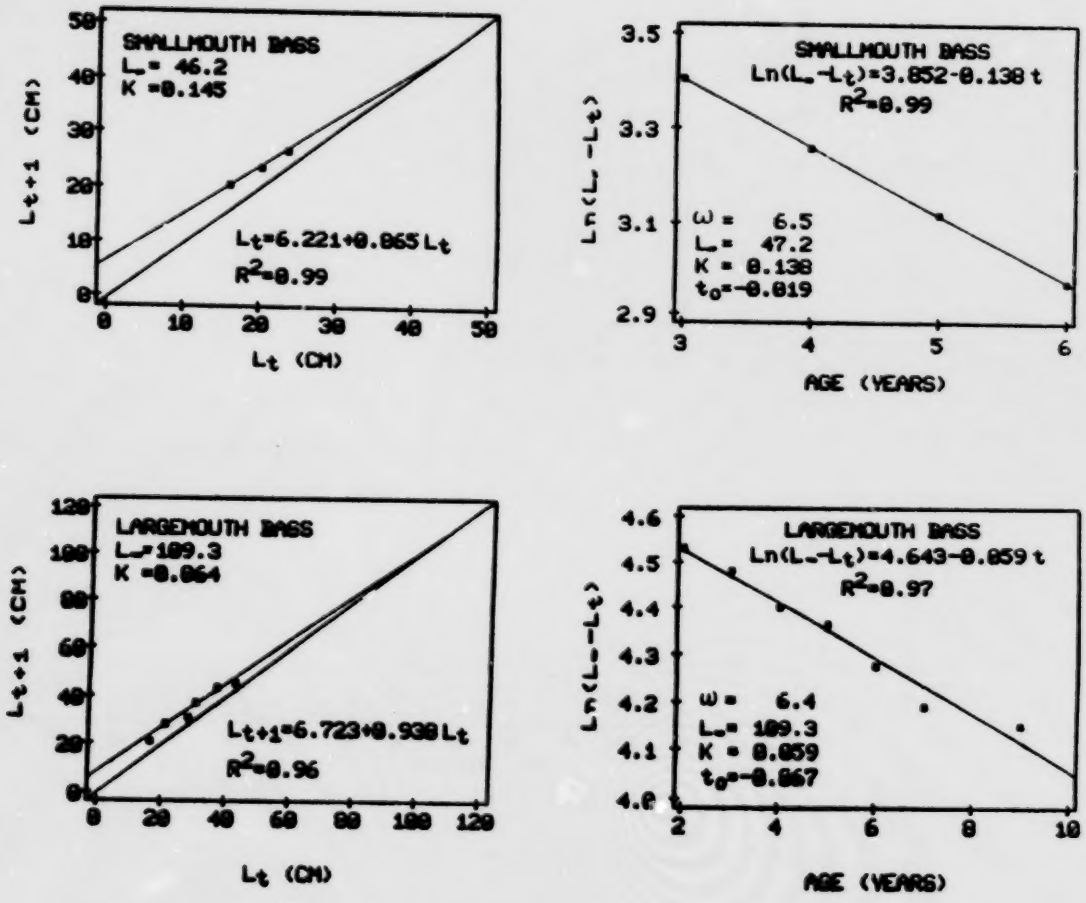


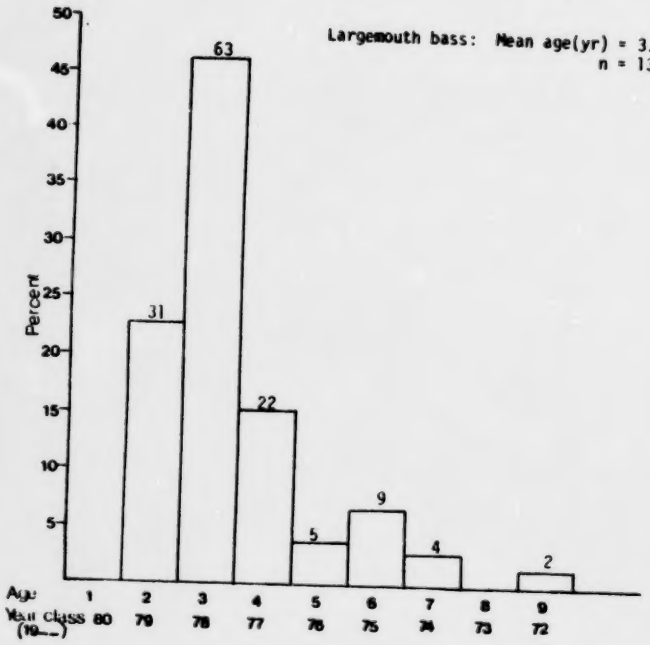
Figure 4.12 Walford, L_{t+1} against L_t, and von Bertalanffy, $Ln(L_\infty - L_t)$ against age, plots, based on mean lengths (cm) at age for smallmouth bass and largemouth bass captured in Big Clear Lake, July 1-10, 1981.

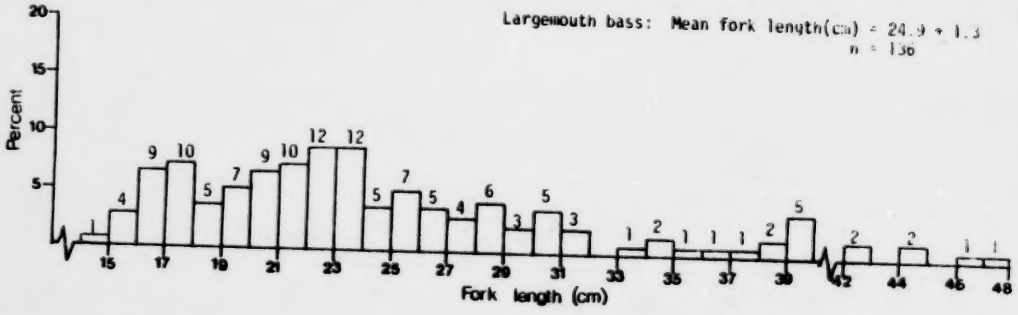
L_∞ is the ultimate length, (cm) of the population.

K is the growth coefficient.

t_0 is the time when length is theoretically zero.

$\omega = K \times L_\infty$ (Galluci and Quinn 1979, based on linear regression).





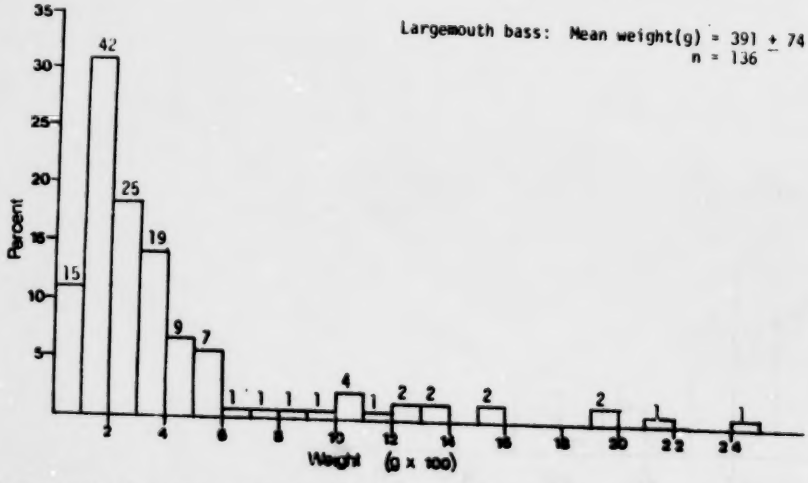
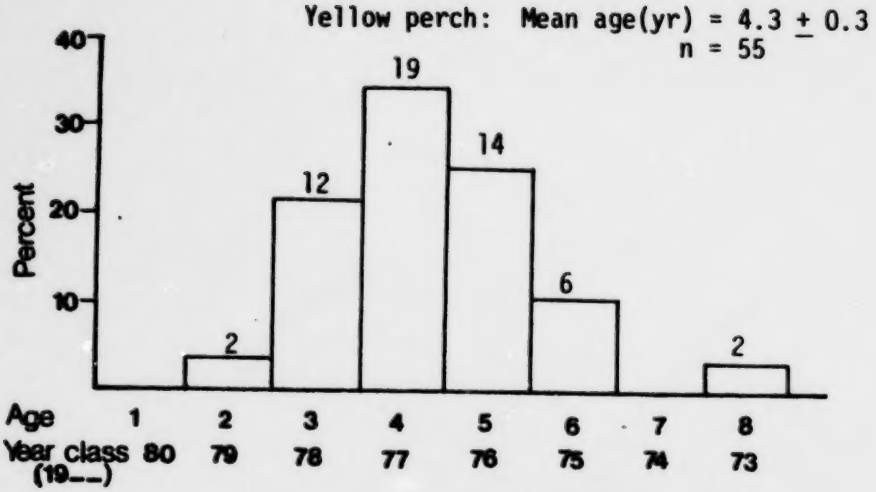
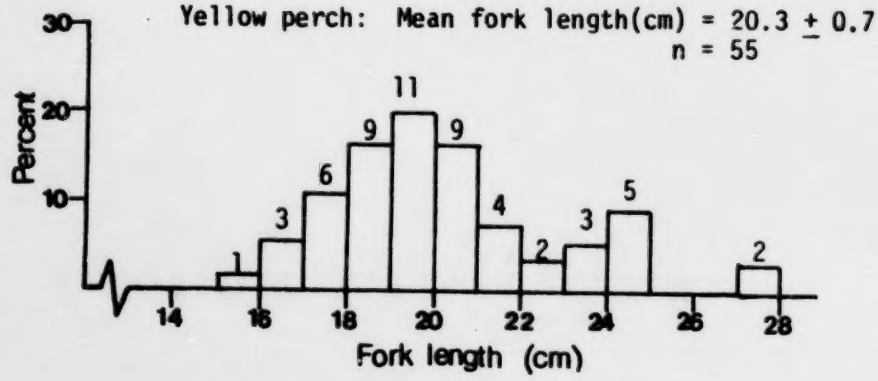


Figure 4.13 Age, fork length and weight distributions of largemouth bass captured in trapnets on Big Clear Lake, July 1-10, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.





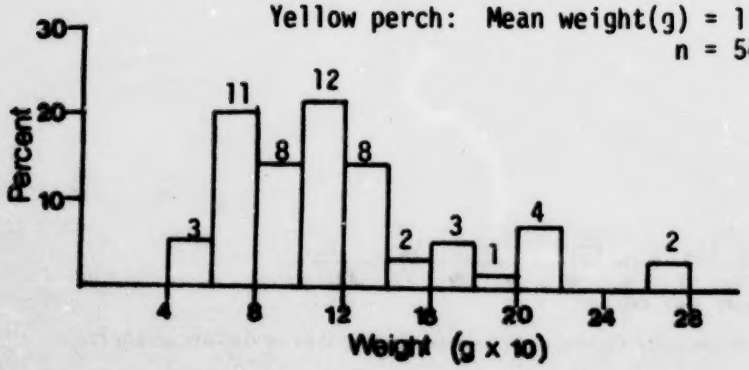


Figure 4.14 Age, fork length and weight distributions of yellow perch captured in trapnets on Big Clear Lake, July 1-10, 1981. Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

4.2 BIG RIDEAU LAKE

4.2.1 Community Structure

Species composition and diversity - Pumpkinseed comprised the greatest percentage of the catch (30.9%), followed by bluegill (21.7%), brown bullhead (17.7%), rock bass (12.7%), yellow perch (5.6%), black crappie (3.8%), smallmouth bass (3.2%), northern pike (2.5%), and largemouth bass (1.0%). Alewife, lake whitefish, white sucker, shorthead redhorse, yellow bullhead, burbot, and walleye each made up <1% of the catch. Most of the fish were caught at trapnet site 2 (Table 4.9, Fig. 4.15).

The relative abundance of fishes in the littoral zone generally parallels the species composition data presented above. In early May, the littoral zone was dominated by pumpkinseed. Brown bullhead, rock bass, and bluegill were moderately abundant. Alewife, lake whitefish, northern pike, white sucker, shorthead redhorse, yellow bullhead, burbot, smallmouth bass, largemouth bass, black crappie, yellow perch, and walleye were present but relatively uncommon (Table 4.10).

Alewife, rare in the trapnets, was the most abundant species in gillnet catches. The ratio of alewife to lake trout was 34.9:1. The ratio of lake herring to lake trout was 2.1:1 (Table 4.10).

The overall Shannon diversity index was 2.67 and ranged from 2.09 (Site 3) to 2.49 (Site 6) for individual trapnet locations (Fig. 4.16).

With respect to species composition, sites 1 and 5 had the highest percentage similarity and with site 3 formed a group of similar trapnet locations. Sites 2 and 6 formed a second group of similar locations and site 4 had the lowest percentage similarity (Fig. 4.16).

Sites 1, 3, and 5 had a higher percentage of pumpkinseed and yellow perch but a lower proportional abundance of bluegill and black crappie than the other three sites (2, 4, and 6) (Fig. 4.17, Table 4.9). Fifty-nine percent of the total variation among the trapnet sites was explained by the differences between the locations defined above (Table 4.11).

The dissimilarity of site 4 accounted for most of the remaining variation (30%) among the trapnets and was the result of a higher percentage of rock bass but lower relative abundance of pumpkinseed and yellow perch compared to the other five sites (1, 2, 3, 5, and 6) (Fig. 4.17, Tables 4.9, 4.11).

4.2.2 Population Characteristics

Lake trout - Lake trout age, fork length, and weight distributions from the 1981 winter and summer sport fisheries are depicted in Figures 4.18 - 4.23. Mean values with 95% confidence limits are shown below.

Sample	Age (yr)	Total Length (cm)	Fork Length (cm)	Weight (g)
Winter				
hatchery	4.9 ± 0.7	44.6 ± 5.3	40.9 ± 5.0	985 ± 461
native	4.8 ± 0.7	48.5 ± 10.0	44.5 ± 9.2	1500 ± 1239
all	4.8 ± 0.5	45.9 ± 4.5	42.2 ± 4.2	1156 ± 431
Summer				
hatchery	4.5 ± 0.4	49.9 ± 3.4	45.9 ± 3.2	1323 ± 524
native	5.3 ± 0.3	53.0 ± 3.0	48.7 ± 2.8	1494 ± 295
all	4.8 ± 0.3	51.3 ± 2.2	47.2 ± 2.1	1404 ± 218

Ages in the winter sport fishery ranged from 3-9 years with the 1976 (age 5) year class the most abundant (Fig. 4.18). Ages in the summer sport fishery ranged from 3-6 years with the 1976 (age 5) year class the most abundant (Fig. 4.21).

Sixty-seven percent of the lake trout sampled during the winter fishery and 53% of those sampled during the summer fishery were of hatchery origin.

The growth rate of lake trout in Big Rideau Lake is greater than expected for Ontario populations. Fork lengths-at-age (Table 4.12) were much greater than the standard growth curve for lake trout (MNR 1983). The growth index for the most abundant year class, age 5, and the mean growth index for all ages were 137% greatly exceeding the provincial standard (MNR 1983) (Table 4.12). The instantaneous growth rate for lake trout was 0.235 ± 0.035 based on ages 3-7 (Fig. 4.24). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.13).

The total mortality rate could not be calculated as a result of atypical catch curves (Figs. 4.18 ,4.21).

Parasitic evaluations, based on a qualitative analysis from summer creel, gillnets, and spawning assessments, indicate that, externally, Salmincola, and internally, tapeworms, commonly affect lake trout living in Big Rideau Lake . Occurrences of fin rot, gill and intestinal flukes, popeye, and leech parasitism were incidental.

Lake trout in Big Rideau Lake appear to be entirely piscivorous. Stomach contents from 15 lake trout were examined. All of the food items were identified as fish products, 52% percent were sculpins, 34% were non-identifiable fish and 14% were alewife. Two of the stomachs were empty.

Lake trout were observed at three of 13 historical spawning shoals monitored, however, a substantial run was only noted at one location (Table 4.14). Spawning depth was 1.0-1.5 m. The mean age (6.3 ± 0.3 yr), mean fork length (63.8 ± 3.4 cm), and mean weight (3341 ± 629) of 18 lake trout sampled during spawning were considerably greater than those of fish captured in the sport fishery (Fig. 4.25). The ratio of male to female lake trout on the spawning shoals was 5:1. Only 17% of these spawning lake trout were of hatchery origin.

Northern pike - The mean age of northern pike captured in the trapnets was 3.4 ± 0.2 years, mean fork length was 48.6 ± 1.2 cm, and mean weight was 855 ± 63 g. Ages ranged from 1-7 years with the 1978 (age 3) year class the most abundant (Fig. 4.26).

The growth rate of Big Rideau Lake northern pike is similar to that expected for Ontario populations. Fork lengths-at-age were greater than the standard growth curve for northern pike (MNR 1983) for ages 1-3, but slightly below for ages 4-7. The mean growth index for all ages was 108% (Table 4.12). The instantaneous growth rate was 0.095 ± 0.036 based on ages 2-7 (Fig. 4.24) The parameters estimated from the Walford (L_∞ =65.3, K=0.312) and von Bertalanffy (L_∞=69.3, K=0.233, t_0=-2.169, ω=16.1) analyses (Table 4.13, Fig.4.27) are similar to those calculated from 18 sets of Ontario data (L_∞=98.31, K=0.145, t_0 =-1.122, ω =14.27) (MNR 1983).

The total mortality rate for northern pike sampled in the trapnets was 0.61 based on ages 3-7 (Table 4.15). This rate is similar to the critical level (0.65) for northern pike (MNR 1983). Ninety-four percent of the sport fishery catch was in the age 3-6 interval (MacLean and Schlesinger 1982). Therefore, the mortality rate for the 3-7 year interval is indicative of the population's response to 1981 effort levels.

Table 4.16 summarizes the percent occurence of external parasites for northern pike sampled during trapnetting. Thirty-seven percent of northern pike were infected by "redsore" disease. These lesions usually prompt numerous enquiries from anxious anglers during creel census (Oleksuik, personal communication).

Smallmouth bass - The mean age of the smallmouth bass taken in the trapnets was 7.9 ± 0.4 years, mean fork length was 37.0 ± 1.2 cm, and mean weight was 918 ± 91 g. Ages ranged from 5-12 years with the 1973 (age 8) year class the most abundant (Fig. 4.28).

The instantaneous growth rate was 0.089 ± 0.026 based on ages 5-11 (Fig. 4.24).

A growth rate slightly higher than that expected for Ontario populations is indicated by the parameters estimated from the Walford (L_∞=52.9, K=0.174) and von Bertalanffy (L_∞=52.9, K=0.184, t_0=1.442, ω=9.7) analyses of Big Rideau Lake smallmouth bass (Table 4.13, Fig.4.27). The estimate of L_∞ is approximately 10% higher than the maximum average population length (45.4 cm, 15 years) but is less than the maximum individual length (58.4 cm) recorded in Ontario (Scott and Crossman 1973).

The total mortality rate for smallmouth bass was 0.52, based on ages 8-12 (Table 4.15). This is similar to the critical level (0.50) for smallmouth bass (MNR 1983). Seventeen percent of the sport fishery catch was in the age 8-12 interval. Nevertheless, because over 1/2 of the sport fishery catch consisted of 6 and 7 year olds (MacLean and Schlesinger 1982), a larger sampling of the younger age classes is necessary before the relationship between mortality and angling levels can be adequately assessed.

Table 4.16 summarizes the percent occurrence of external

parasites for target species sampled during trapnetting. Blackspot was the most common parasitic condition observed on smallmouth bass.

Largemouth bass - The mean age of the trapnetted largemouth bass was 6.7 ± 0.4 years, mean fork length was 32.9 ± 1.4 cm, and mean weight was 728 ± 89 g. Ages ranged from 2-11 years with the 1973, 1974, and 1975 year classes (ages 6-8) the most abundant (Fig. 4.29).

The instantaneous growth rate was 0.105 ± 0.019 based on ages 2-11 (Fig. 4.24).

The growth parameters calculated from the Walford (L_∞=55.3, k=0.127) and von Bertalanffy (L_∞=55.3, k=0.135, t_0=-0.235, ω'=7.5) analyses for ages 4-10 appear to be realistic estimates (Table 4.13, Fig. 4.27).

The total mortality rate of the largemouth bass sampled on Big Rideau Lake was 0.60 based on ages 8-11 (Table 4.15). Thirty percent of the sport fishery catch was in the age 8-11 interval. Nevertheless, because more than 1/2 of the sport fishery harvest consisted of ages 6 and 7 (MacLean and Schlesinger 1982), a larger sampling of the younger year classes is necessary before the relationship between mortality and angling levels can be adequately assessed.

Blackspot was the most common external parasite observed on largemouth bass during trapnetting (Table 4.16).

Yellow perch - The mean age of the yellow perch taken in the trapnets was 6.3 ± 0.4 years, mean fork length was 21.0 ± 0.8 cm, and mean weight was 141 ± 18 g. Ages ranged from 3-10 years with the 1975 (age 6) year class the most abundant (Fig. 4.30).

The instantaneous growth rate was 0.085 ± 0.018 based on ages 3-10 (Fig. 4.24).

The total mortality rate of the yellow perch trapnetted on Big Rideau Lake was 0.51, based on ages 6-10 (Table 4.15).

Blackspot was the most common external parasite observed on yellow perch during trapnetting (Table 4.16).

Table 4.9 Species composition and total catch at Big Rideau Lake during May 6-15, 1981 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN3	TN4	TN5	TN6	All Sites	Total Catch
Alewife	0.1			0.2		0.1	<0.1	5
Lake whitefish			0.1	0.2			<0.1	2
Northern pike	1.0	2.6	2.5	0.5	0.5	5.6	2.5	234
White sucker	0.1	1.0		0.2	1.4	0.3	0.6	58
Shorthead redhorse		0.1					<0.1	2
Yellow bullhead	0.3	0.2		0.2	0.2	0.1	0.2	16
Brown bullhead	25.0	12.9	12.9	10.7	17.9	23.3	17.7	1672
Burbot		<0.1					<0.1	1
Rock bass	20.1	6.9	22.4	41.9	9.9	4.1	12.7	1199
Pumpkinseed	32.6	32.0	49.2	14.7	40.8	16.2	30.9	2927
Bluegill	8.2	34.8	2.5	13.2	8.3	34.1	21.7	2057
Smallmouth bass	2.0	3.2	5.5	5.7	1.7	0.3	3.2	301
Largemouth bass	0.1	1.9				2.0	1.0	99
Black crappie	0.5	3.1		2.0	0.1	13.3	3.8	362
Yellow perch	10.1	1.2	4.8	0.2	19.0	0.7	5.6	528
Walleye		<0.1		0.4	0.1		<0.1	5
Total catch	1671	3094	906	559	1389	1849		9468
Percent catch	17.6	32.7	9.6	5.9	14.7	19.5	100.0	

Table 4.10 CUE for fishes caught at Big Rideau Lake during 1981 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear-Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Lake trout		3.5
Alewife	0.1	122.3
Lake whitefish	0.1	2.5
Lake herring		7.5
Northern pike	4.3	4.8
White sucker	1.1	1.8
Shorthead redhorse	0.1	
Yellow bullhead	0.3	
Brown bullhead	31.0	9.0
Burbot	0.1	2.5
Rock bass	22.2	11.8
Pumpkinseed	54.2	4.8
Bluegill	38.1	3.0
Smallmouth bass	5.6	3.0
Largemouth bass	1.8	
Black crappie	6.7	0.3
Yellow perch	9.8	9.3
Walleye	0.1	
Deepwater sculpin		0.3

Table 4.11 First two principal components for the six most abundent species caught in trapnets on Big Rideau Lake, May 6-15, 1981.

Species	Principal Component	
	1	2
Brown bullhead	-0.04	0.22
Rock bass	0.35	-0.73
Pumpkinseed	0.35	0.39
Bluegill	-0.66	0.09
Black crappie	-0.42	-0.01
Yellow perch	0.37	0.51
Percent variance	59.2	29.6
Cummulative variance	59.2	88.8

Table 4.12 Mean fork length-at-age (cm), 95% confidence limits and growth indices[1] for fishes caught in Big Rideau Lake, 1981. Values in parentheses are sample sizes.

Species		Age												Mean Growth Index
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Lake trout	Mean			26.8±3.1	34.9±4.8	43.6±2.7	58.2±1.9	67.1±9.7	64.7±NA					
	GI			120	125	133	147	147	126					133
				(4)	(6)	(16)	(4)	(4)	(1)					
Northern pike	Mean	35.4±1.8	44.5±1.6	48.5±1.1	52.4±2.1	55.4±3.2	59.5±3.2	56.7±NA						
	GI	153	120	105	99	100	95	85						109
		(10)	(37)	(79)	(36)	(18)	(8)	(1)						
Smallmouth bass	Mean					25.9±0.9	28.8±1.7	33.4±1.0	32.3±1.0	41.3±1.0	41.7±2.1	43.3±3.2	39.2±NA	
						(T1)	(38)	(31)	(33)	(T8)	(9)	(6)	(T)	
Largemouth bass	Mean		18.3±NA	18.6±26.7	24.6±1.8	27.5±1.7	30.8±1.6	34.8±1.3	37.4±1.4	40.0±2.1	40.9±3.6	46.1±NA		
			(T1)	(2)	(T0)	(T3)	(T5)	(T4)	(T5)	(T2)	(4)	(T)		
Yellow perch	Mean			15.8±0.6	17.3±1.4	17.4±0.6	21.6±0.5	21.8±0.8	25.7±1.6	25.6±1.5	28.0±5.1			
				(T0)	(T0)	(T0)	(44)	(22)	(T5)	(T3)	(3)			

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for lake trout and northern pike (MNR 1983).

Table 4.13 Walford and Von Bertalanffy growth parameters for target species caught in Big Rideau Lake, 1981. Blank spaces indicate data which did not fit the Von Bertalanffy model.

Species	Ages	Walford			Von Bertalanffy				
		L_{∞} (cm)	K	R^2	L_{∞} (cm)	K	t_o	ω	R^2
Lake trout	3 - 8	81.5	0.242	0.87					
Northern pike	1 - 6	65.3	0.312	0.95	69.3	0.233	-2.169	16.1	0.99
Smallmouth bass	5 - 12	52.9	0.174	0.95	52.9	0.184	1.442	9.7	0.98
Largemouth bass	4 - 10	55.3	0.127	0.98	55.3	0.135	-0.235	7.5	0.99

[1] $\omega = K \times L_{\infty}$ (Gallucci and Quinn 1979, based on a linear regression of Ln $(L_{\infty} - L_t)$ against age.

Table 4.14 The number of lake trout observed during spawning investigations at 12 shoals on Big Rideau Lake, 19 October - 3 November, 1981.
Blank spaces denote missing data due to weather or logistical constraints.

Date	Shoal												
	1	2	3	4	5	6	6a	7	8	9	10	11	12
October 19		0			0							0	
October 21		0	0									0	
October 25		2			0							7	
October 29	0	0	0	0	0	0	17	0	0	0	0	0/0	0
October 30		0			0	0	6/3	1				0	
November 3		0			0			0				0	

#/# denotes 2 observations on same night.

Table 4.15 Total mortality rates for target species captured in trapnets on Big Rideau Lake in 1981.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.61	0.37 - 0.77	3 - 7
Smallmouth bass	0.52	0.38 - 0.62	8 - 12
Largemouth bass	0.60	0.11 - 0.82	8 - 11
Yellow perch	0.51	0.32 - 0.64	6 - 10

Table 4.16 The percent occurrence of visible external parasites for target species sampled during trapnetting in Big Rideau Lake, May 6-15, 1981.
Blank spaces denote that no parasites were observed.

Species	No.	Parasite		
		Blackspot	Red sore	Yellow grub
Northern pike	192	46	37	
Smallmouth bass	205	28		1
Largemouth bass	96	30		
Yellow perch	129	14		7

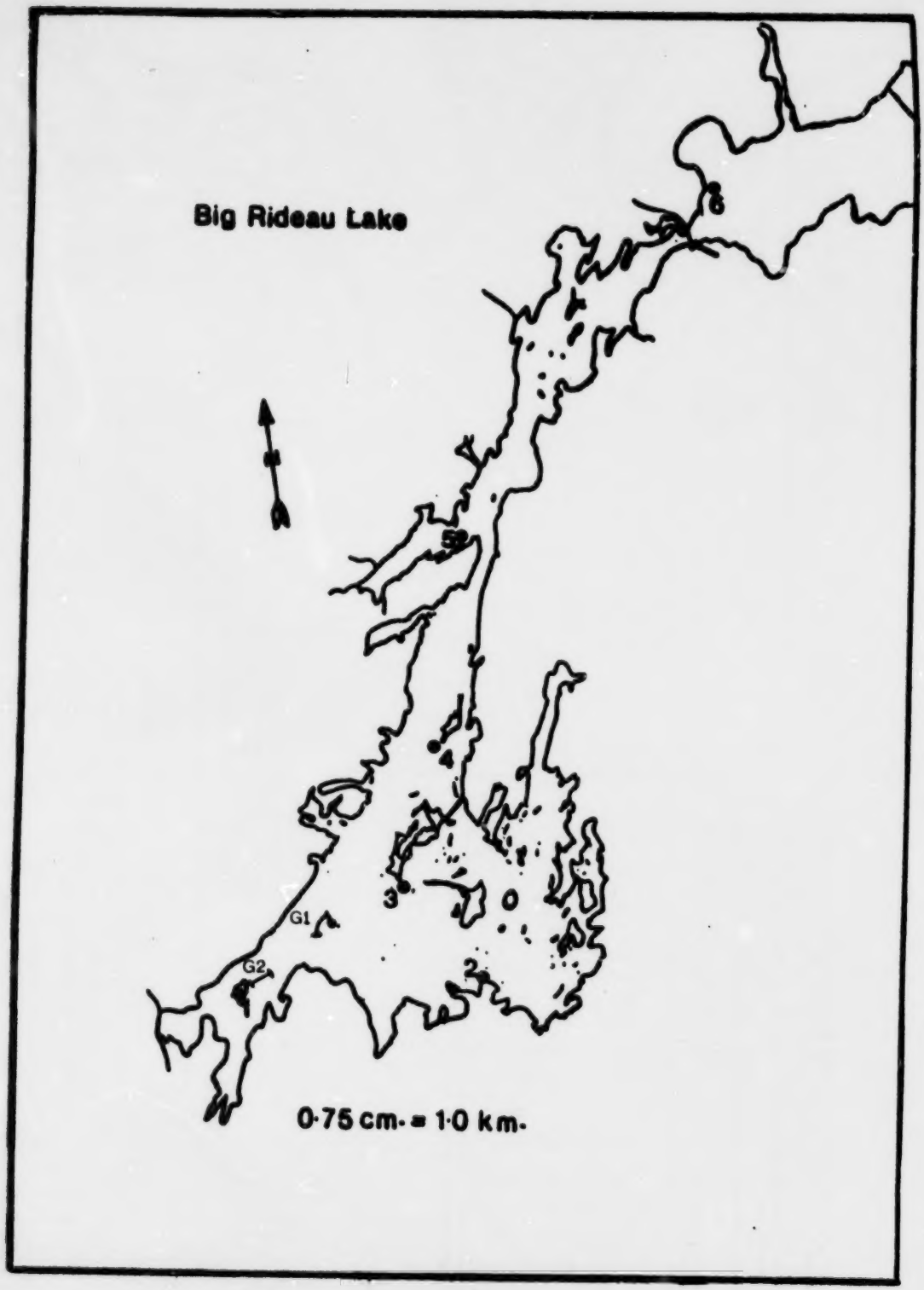


Figure 4.15 Index netting gear locations on Big Rideau Lake, 1981.

● = trapnet location.
⟷ = gillnet location.

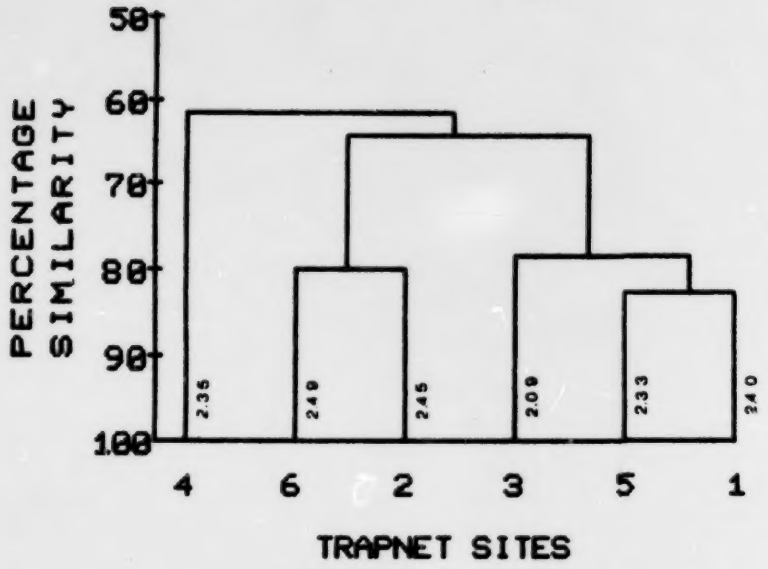


Figure 4.16 The percentage similarity between the trapnet sites on Big Rideau Lake, May 6-15, 1981. The number next to each cluster is the diversity index for the respective sites.

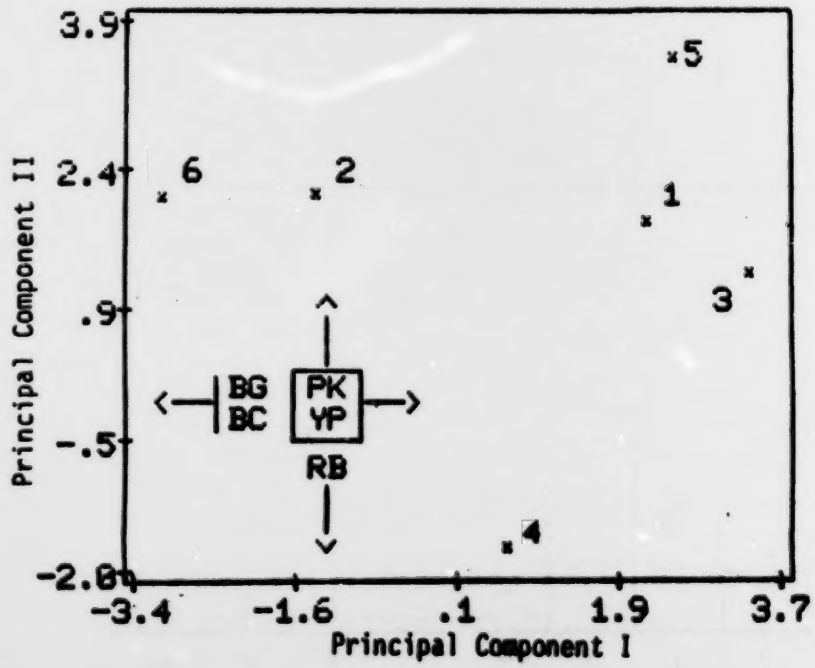


Figure 4.17 The major differences in species composition between the Big Rideau Lake trapnet sites, May 6-15, 1981. With respect to each axis (principal component), the arrows indicate the direction of increasing proportional abundance of the designated species.
BG, bluegill; BC, black crappie; PK, pumpkinseed, YP, yellow perch; RB, rock bass.

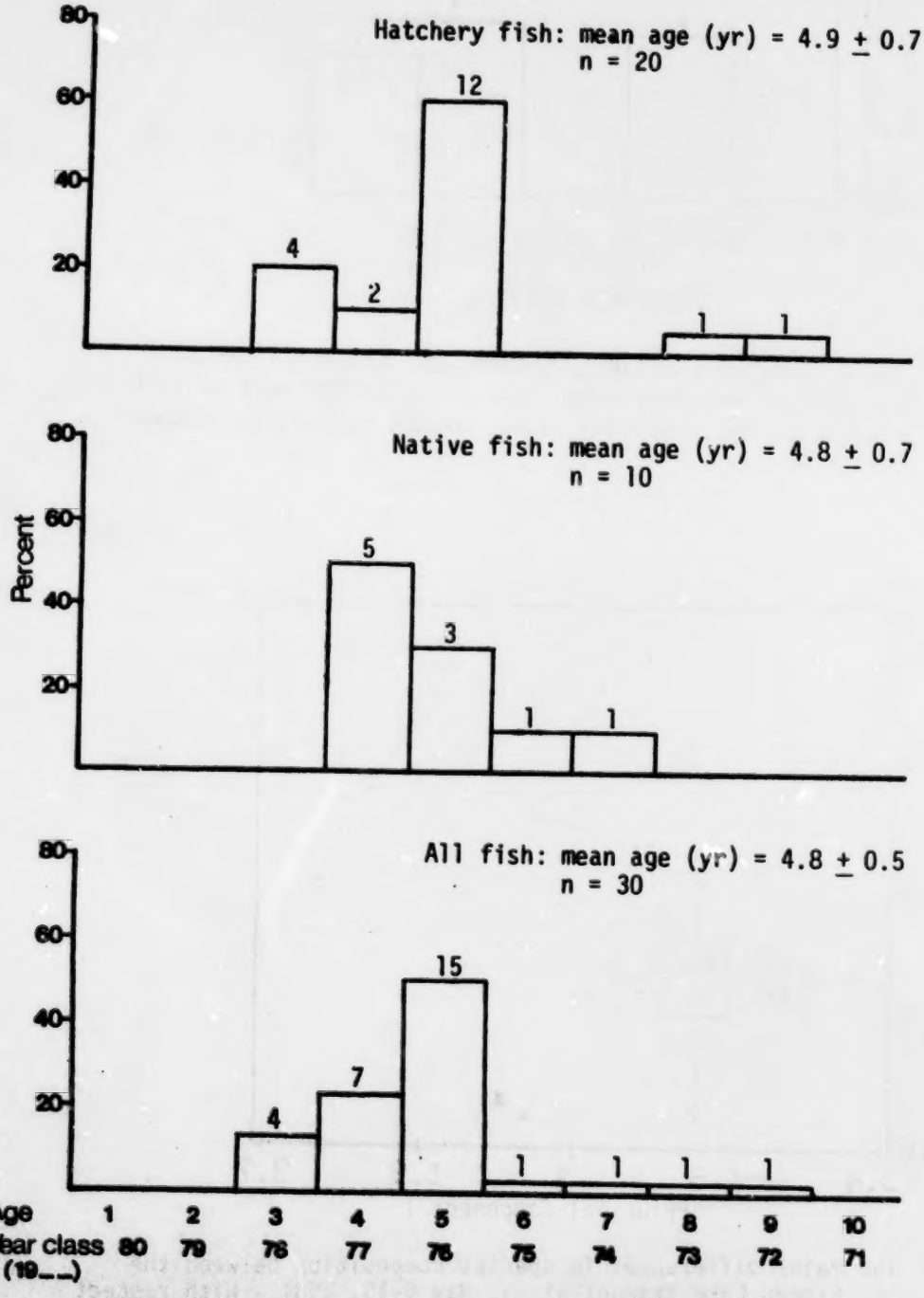


Figure 4.18 Age distributions of lake trout sampled during the winter 1981 sport fishery on Big Rideau Lake.
Numbers over each bar indicate actual count frequencies.

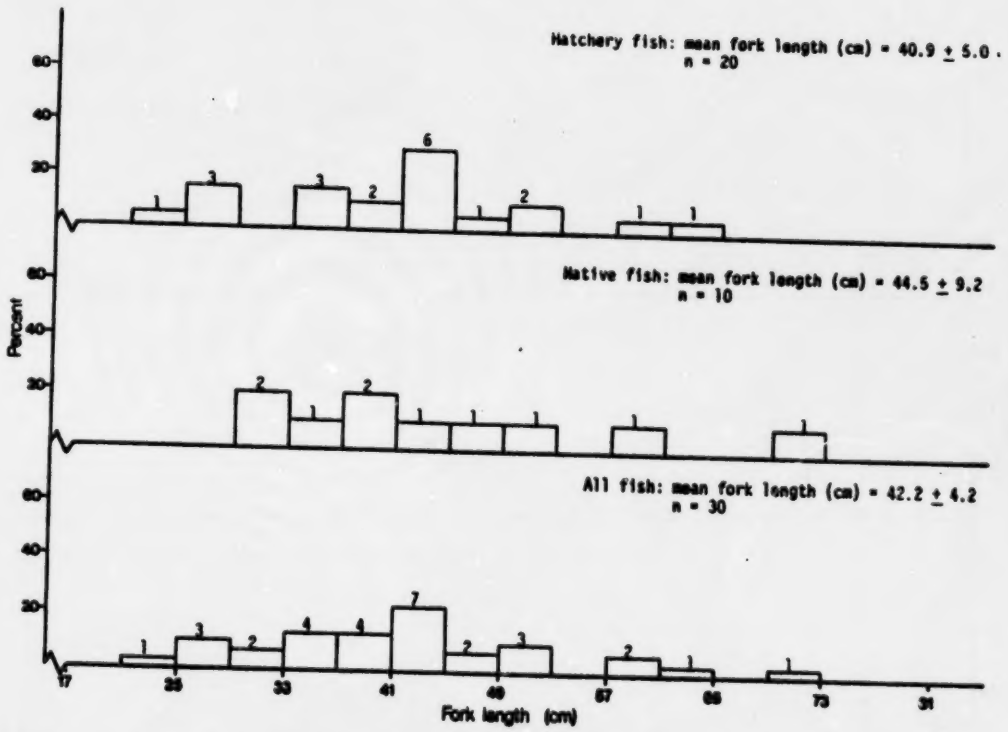

Hatchery fish: mean fork length (cm) = 40.9 ± 5.0 .
n = 20
Native fish: mean fork length (cm) = 44.5 ± 9.2
n = 10
All fish: mean fork length (cm) = 42.2 ± 4.2
n = 30
Percent
Fork length (cm)

Figure 4.19 Fork Length distributions of lake trout sampled during the winter 1981 sport fishery on Big Rideau Lake. Numbers over each bar indicate actual count frequencies.

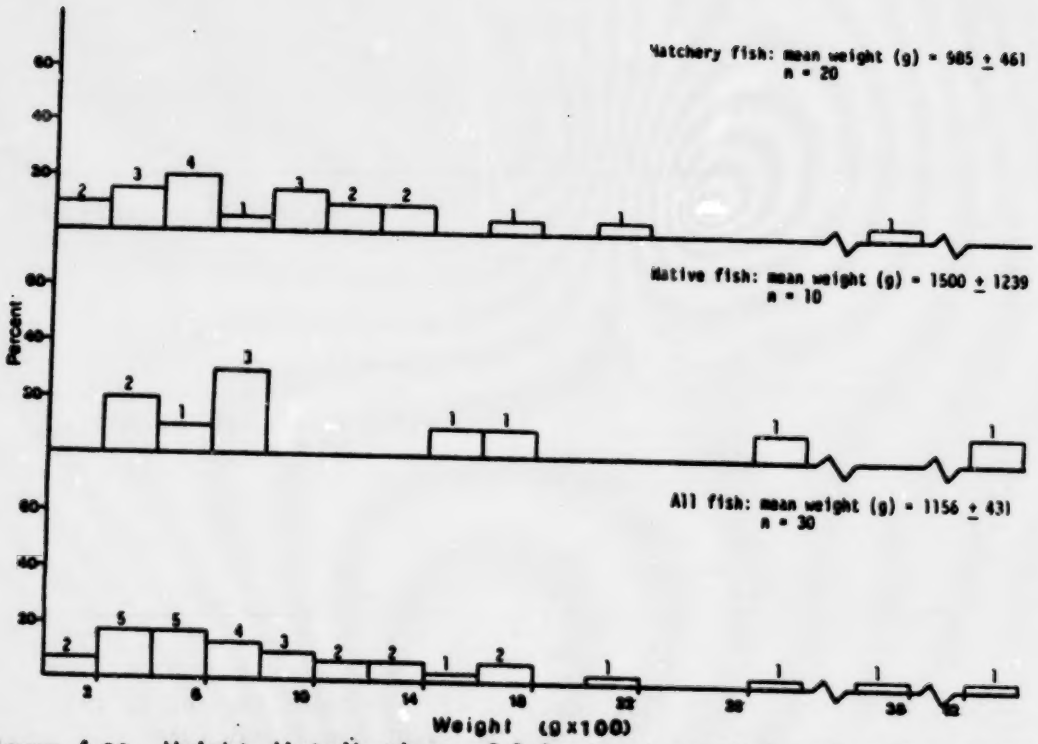

Hatchery fish: mean weight (g) = 585 ± 461
n = 20
Native fish: mean weight (g) = 1500 ± 1239
n = 10
All fish: mean weight (g) = 1156 ± 431
n = 30
Percent
Weight (g x100)

Figure 4.20 Weight distributions of lake trout sampled during the winter 1981 sports fishery on Big Rideau Lake.
Numbers over each bar indicate actual count frequencies.

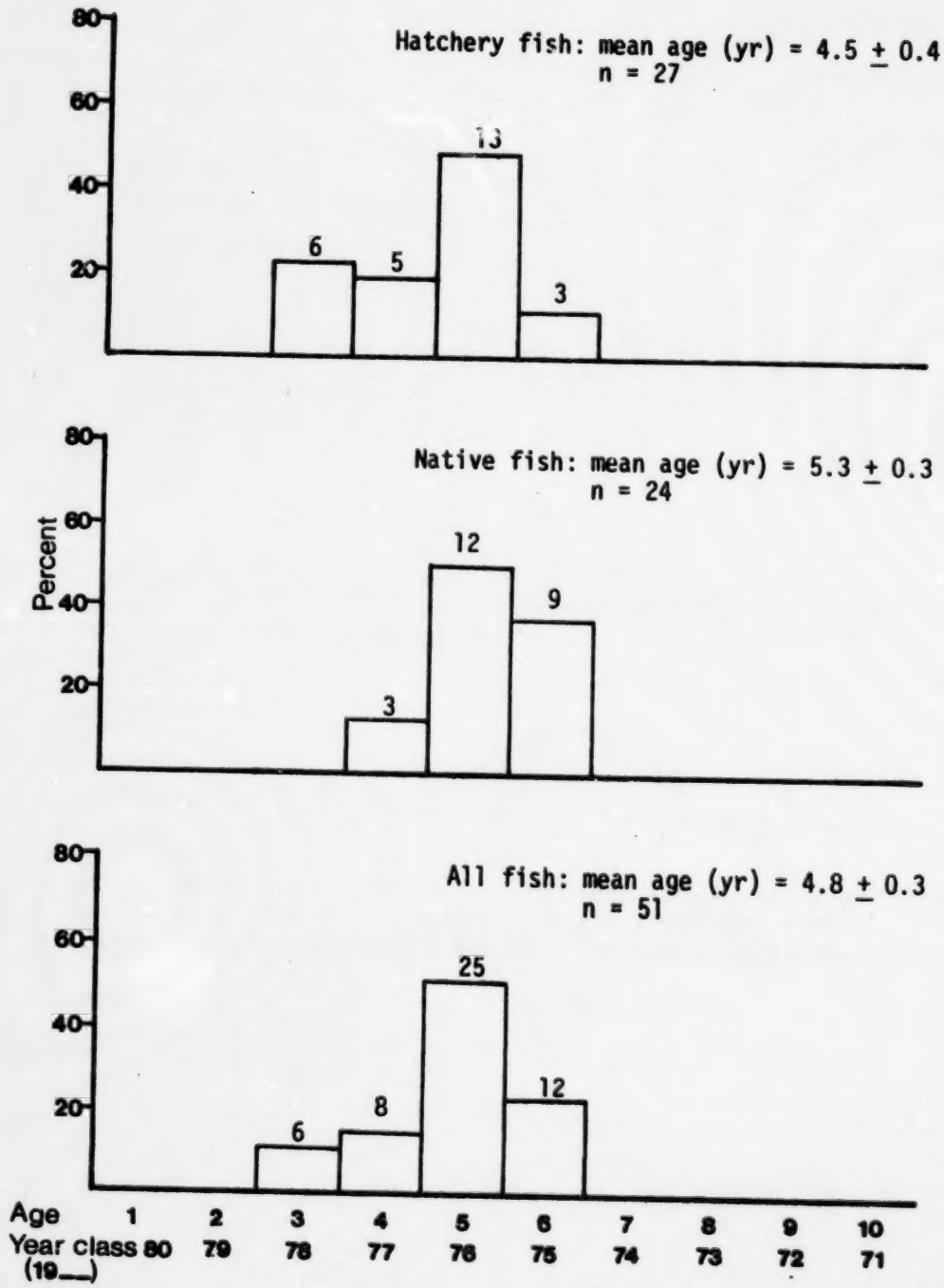


Figure 4.21 Age distributions of lake trout sampled during the summer 1981 sport fishery on Big Rideau Lake. Numbers over each bar indicate actual count frequencies.

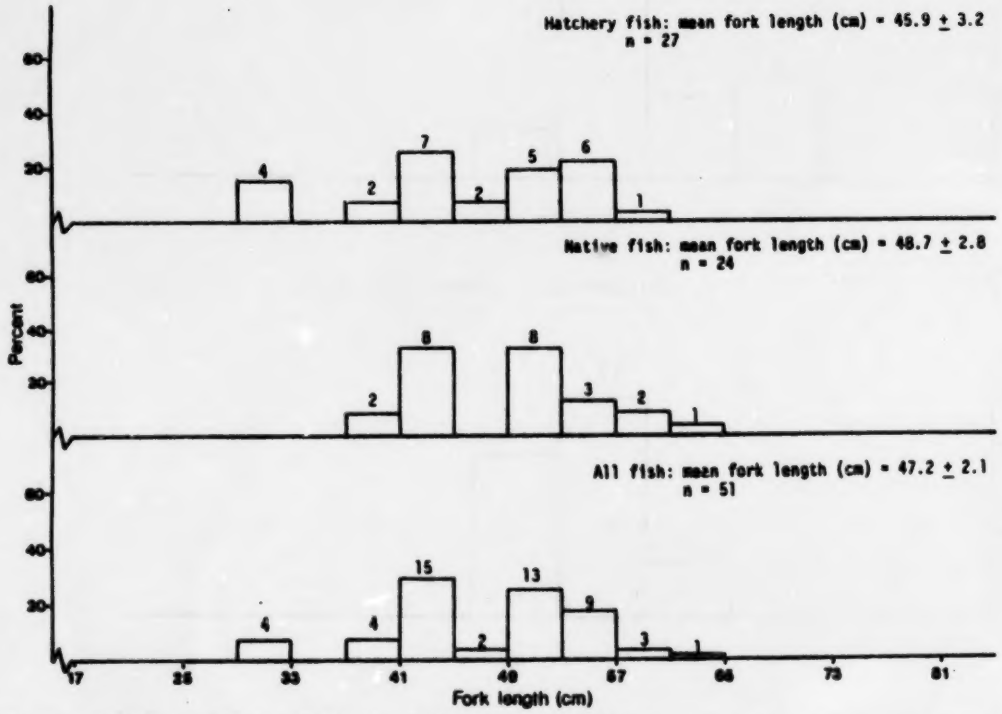


Figure 4.22 Fork length distributions of lake trout sampled during the summer 1981 sport fishery on Big Rideau Lake. Numbers over each bar indicate actual count frequencies.

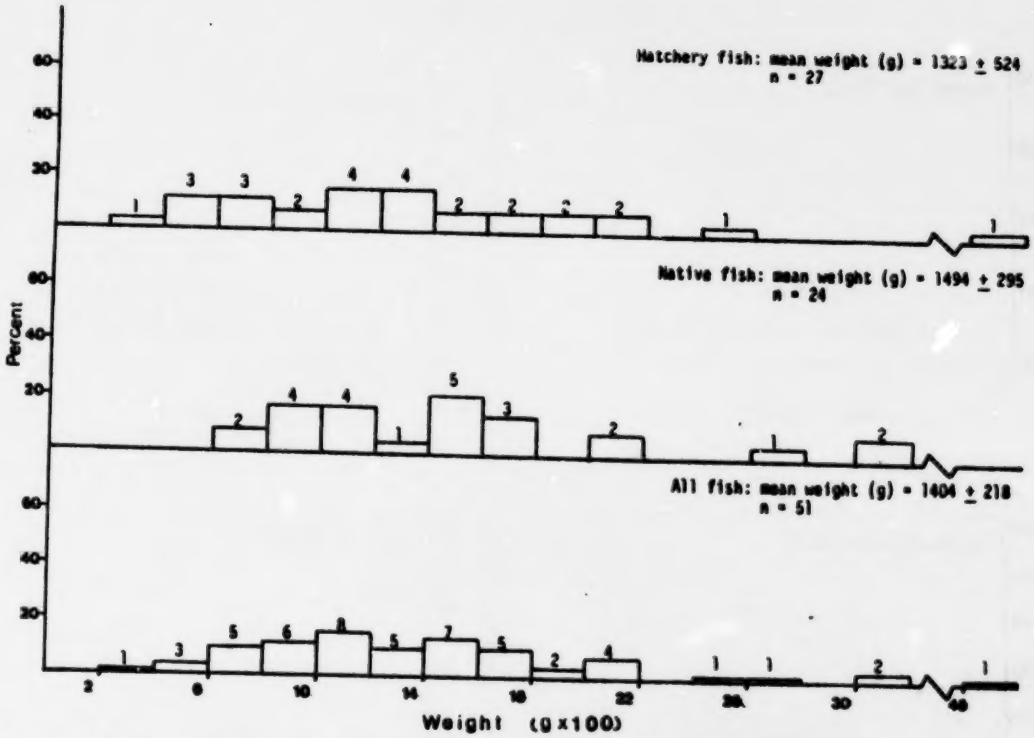

Hatchery fish: mean weight (g) = 1323 ± 524
n = 27
Native fish: mean weight (g) = 1494 ± 295
n = 24
All fish: mean weight (g) = 1404 ± 218
n = 51
Percent
Weight (g x100)

Figure 4.23 Weight distributions of lake trout sampled during the summer 1981 sport fishery on Big Rideau Lake. Numbers over each bar indicate actual count frequencies.

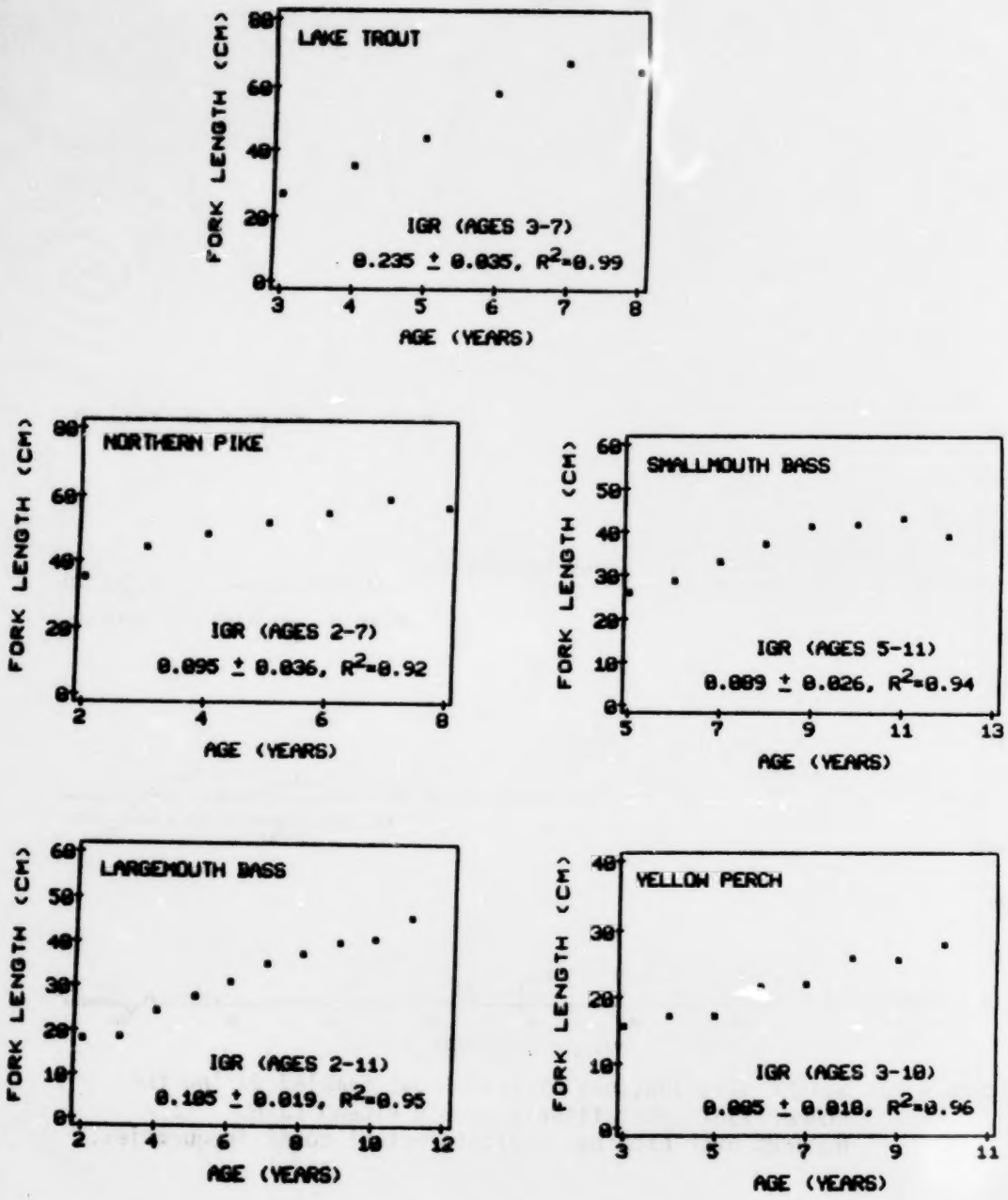


Figure 4.24 Absolute growth rate of lake trout, northern pike, smallmouth bass, largemouth bass, and yellow perch sampled at Big Rideau Lake, 1981. Lake trout were sampled during the winter 1981 creel census. The other target species were sampled during the index trapnetting, May 6-15, 1981. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

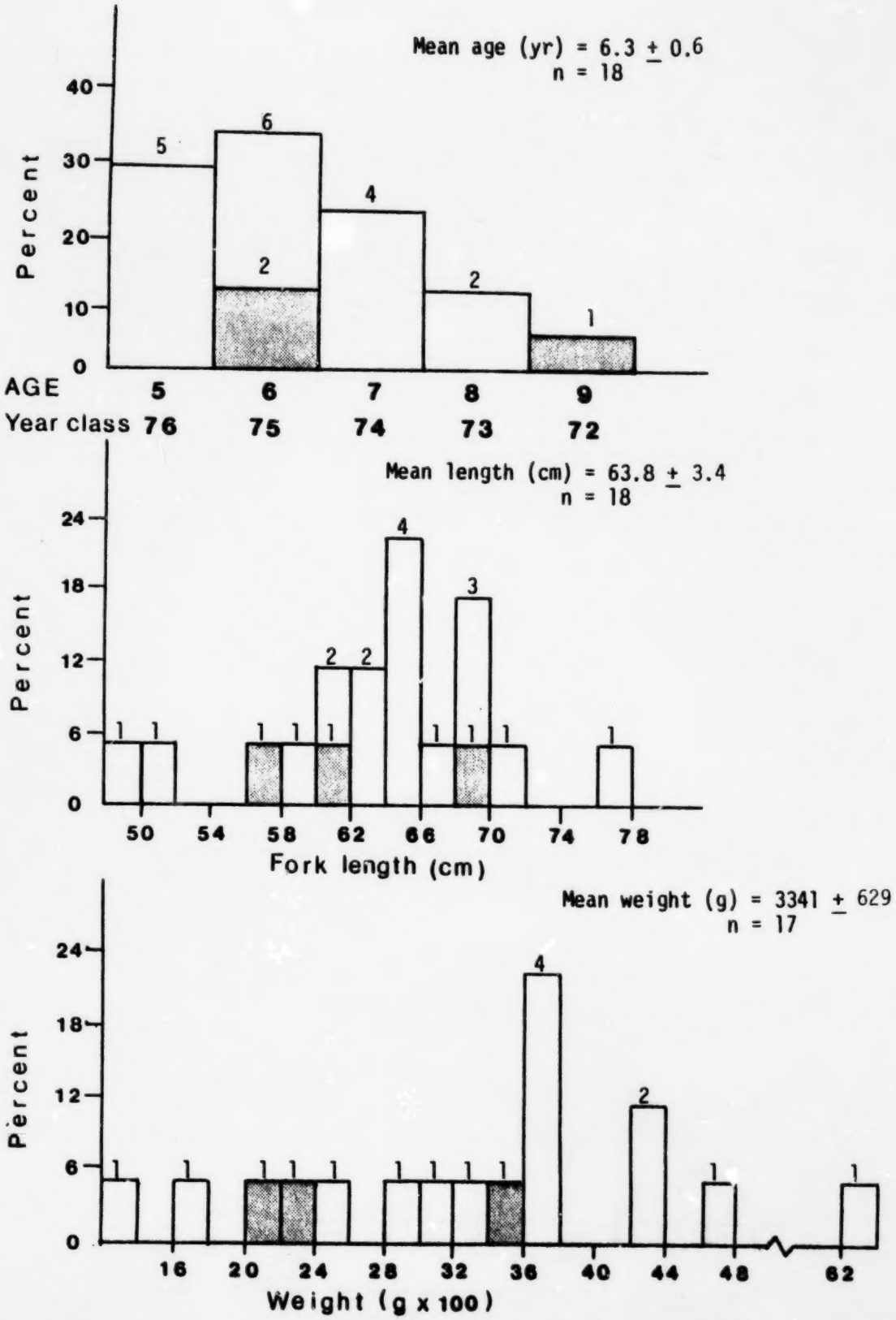
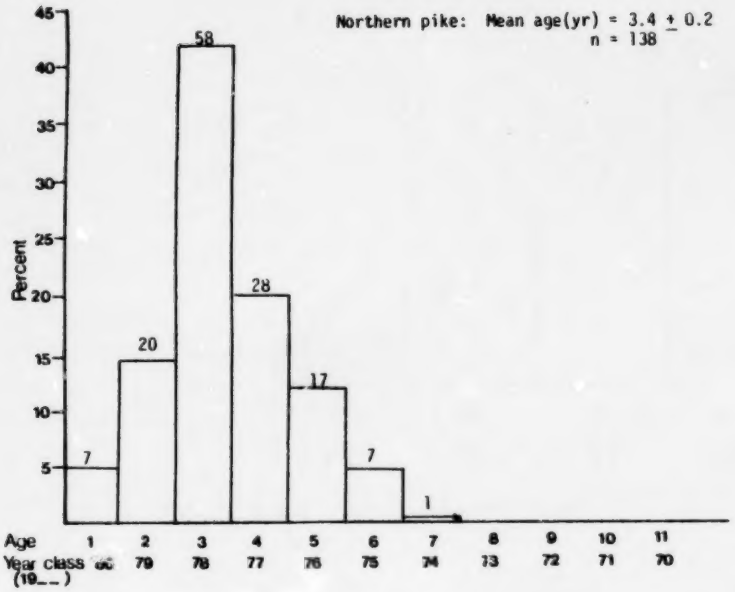
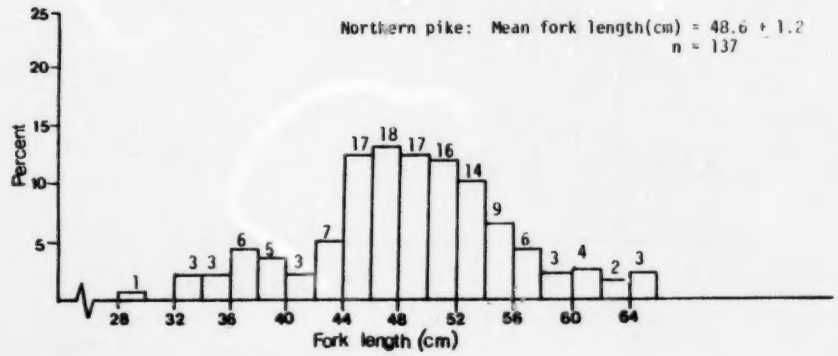

Mean age (yr) = 6.3 ± 0.6
n = 18
Percent
AGE
Year class
5 6 7 8 9
76 75 74 73 72
Mean length (cm) = 63.8 ± 3.4
n = 18
Percent
Fork length (cm)
50 54 58 62 66 70 74 78
Mean weight (g) = 3341 ± 629
n = 17
Percent
Weight (g x 100)
16 20 24 28 32 36 40 44 48 62

Figure 4.25 Age, fork length, and weight distributions of lake trout sampled during spawning assessment on Big Rideau Lake, October 25-29, 1981.
Numbers over each bar indicate actual count frequencies.
■ indicates fish of hatchery origin.





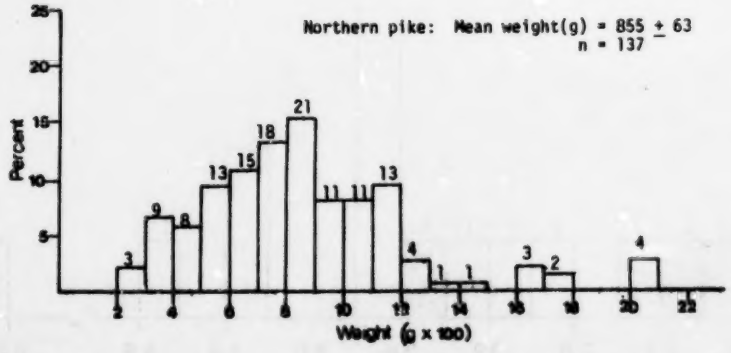


Figure 4.26 Age, fork length, and weight distributions of northern pike captured in trapnets on Big Rideau Lake, May 6-15, 1981.
Numbers over each bar indicate actual count frequencies.

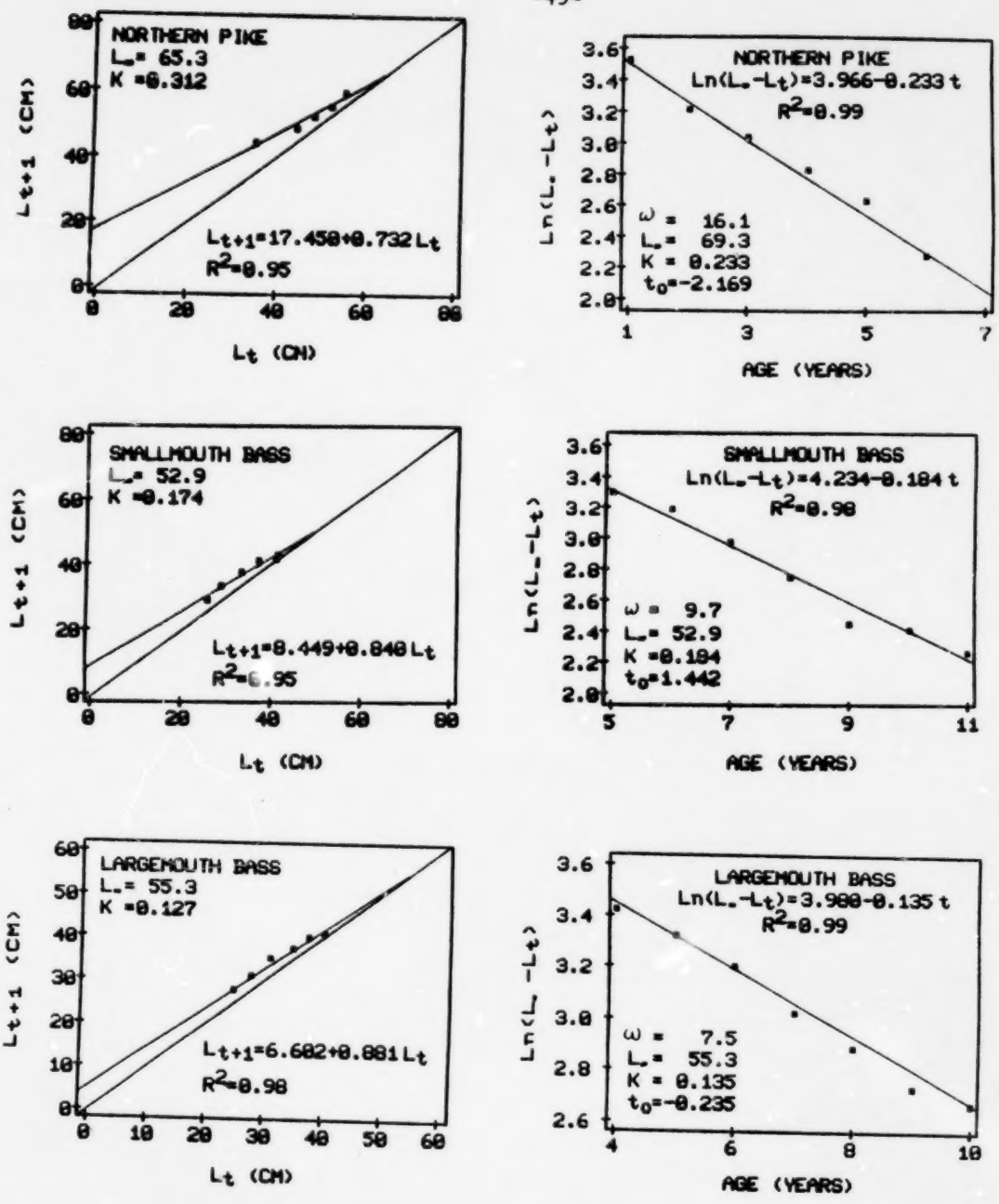


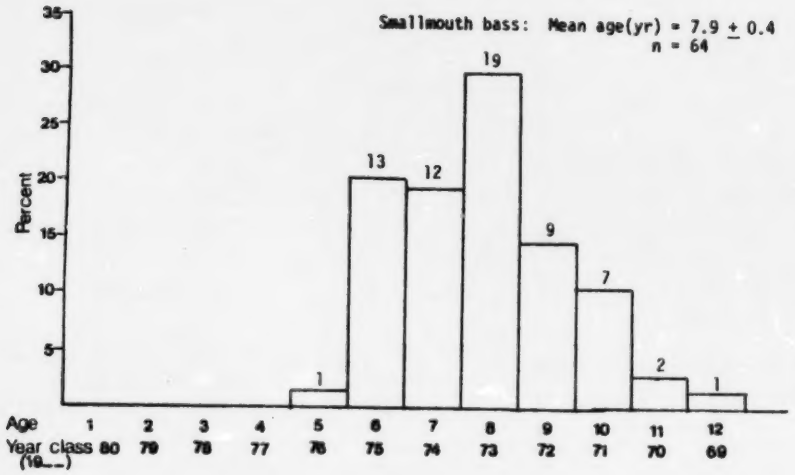
Figure 4. 27 Walford, L_{t+1} against L_t, and von Bertalanffy, $Ln(L_\infty - L_t)$ against age, plots, based on mean lengths (cm) at age for northern pike, smallmouth bass and largemouth bass captured in Big Rideau Lake, May 6-15, 1981.

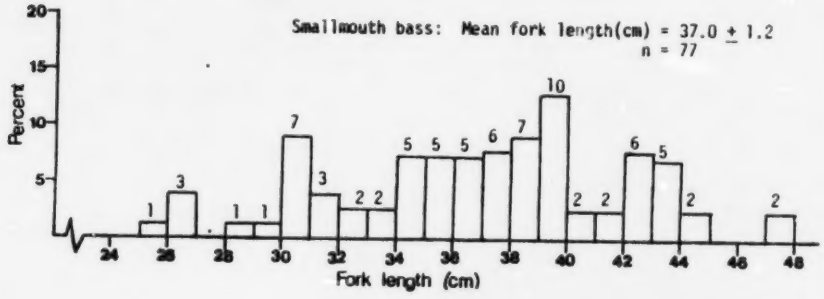
L_∞ is the ultimate length, (cm) of the population.

K is the growth coefficient.

t_0 is the time when length is theoretically zero.

$\omega = K \times L_\infty$ (Galluci and Quinn 1979, based on linear regression).





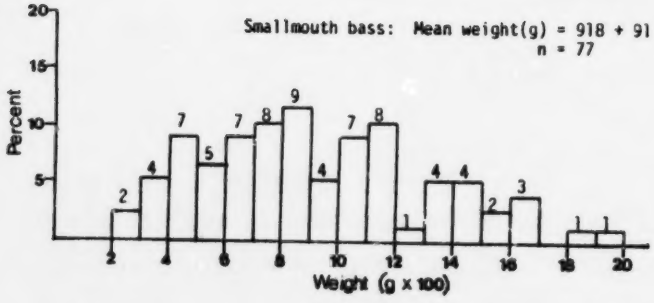


Figure 4.28 Age, fork length, and weight distributions of smallmouth bass captured in trapnets on Big Rideau Lake, May 6-15, 1981.
Numbers over each bar indicate actual count frequencies.

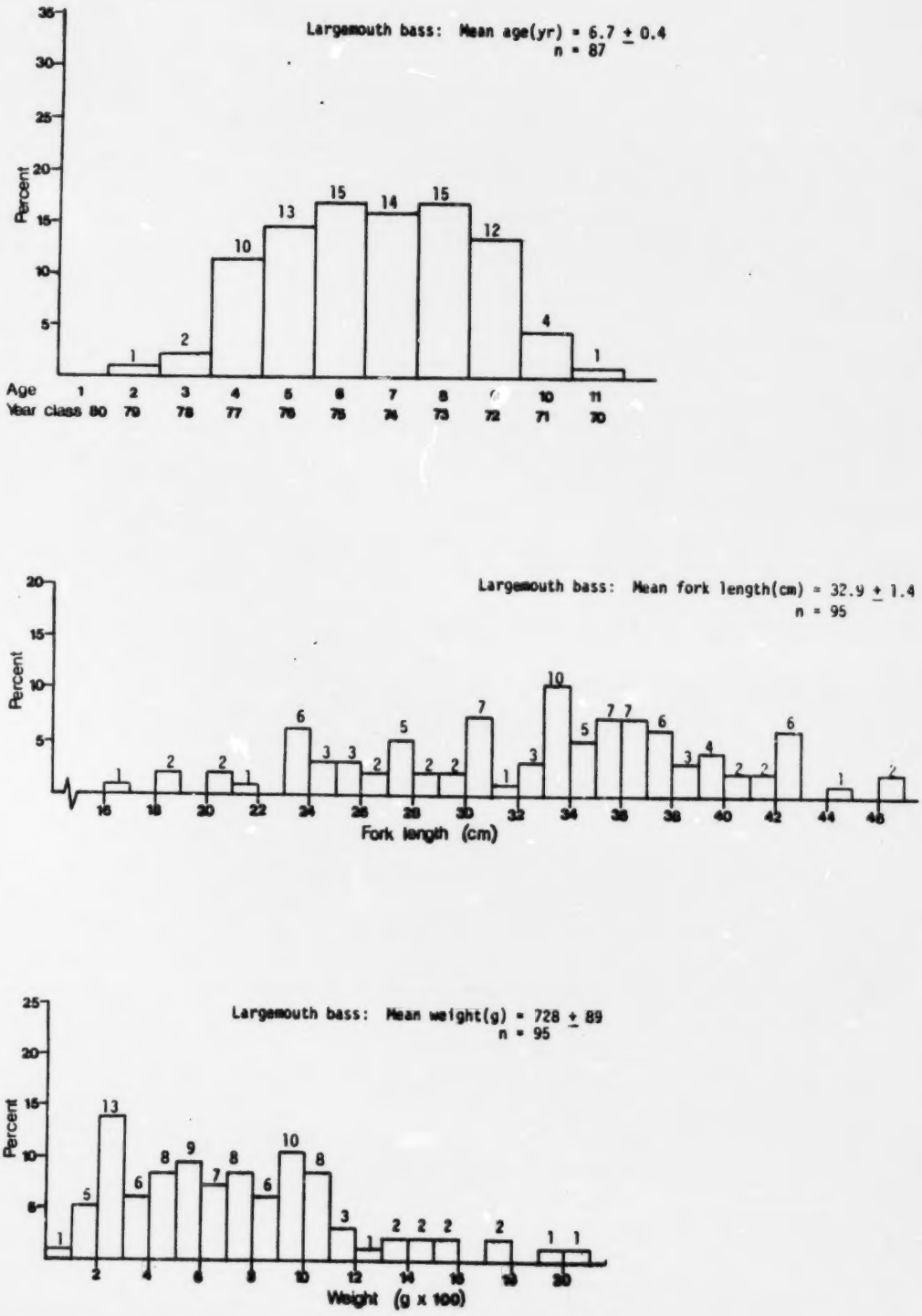
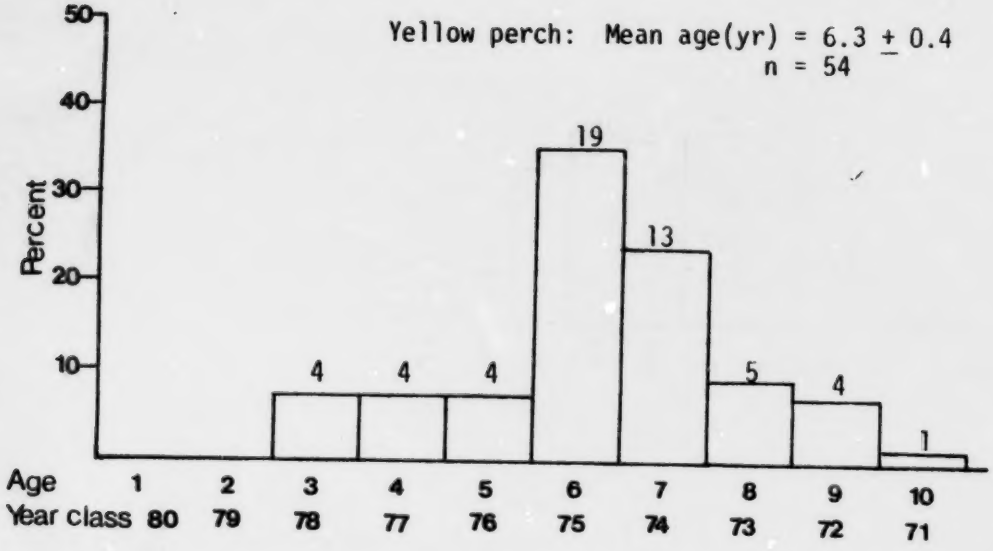
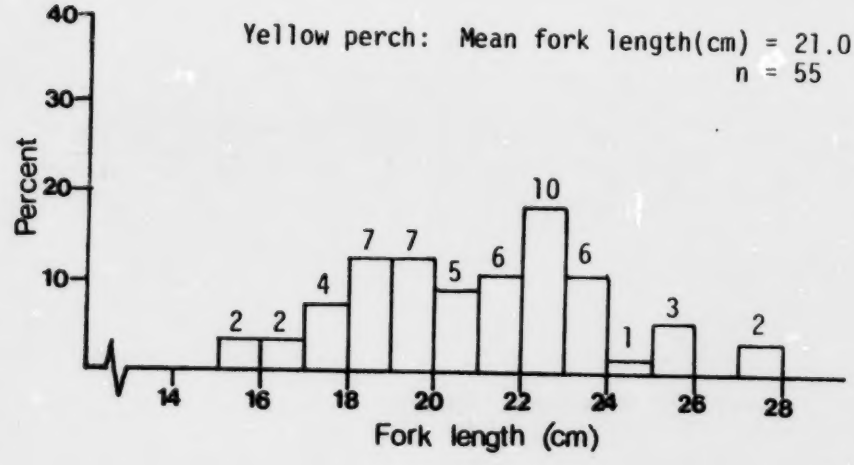

Largemouth bass: Mean age(yr) = 6.7 ± 0.4
n = 87
Percent
Age
Year class
Largemouth bass: Mean fork length(cm) = 32.9 ± 1.4
n = 95
Fork length (cm)
Largemouth bass: Mean weight(g) = 728 ± 89
n = 95
Weight (g x 100)

Figure 4.29 Age, fork length, and weight distributions of largemouth bass captured in trapnets on Big Rideau Lake, May 4-15, 1981.
Numbers over each bar indicate actual count frequencies.





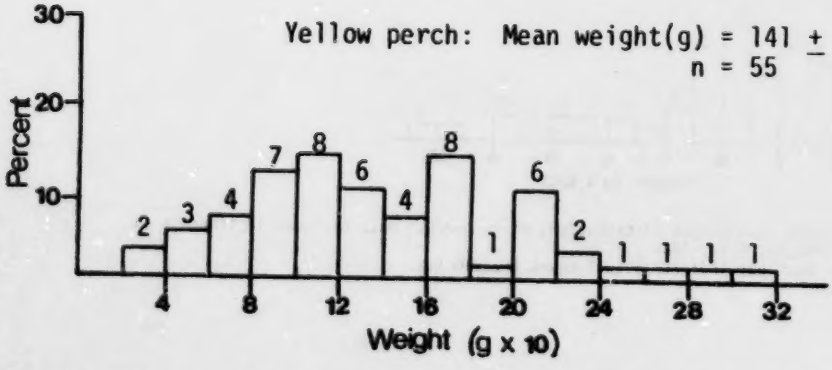


Figure 4.30 Age, fork length, and weight distributions of yellow perch captured in trapnets on Big Rideau Lake, May 6-15, 1981. Numbers over each bar indicate actual count frequencies.

4.3 BIG SALMON LAKE

4.3.1 Community Structure

Species composition and diversity - Bluegill comprised the greatest percentage of the catch (50.3%), followed by pumpkinseed (14.8%), white sucker (9.9%), rock bass (8.0%), brown bullhead (3.9%), largemouth bass (3.5%), yellow perch (3.5%), smallmouth bass (3.3%), and lake herring (1.7%). Golden shiner, fallfish, and yellow bullhead each made up <1% of the catch. Most of the fish were caught at trapnet site 7 (Table 4.17, Figure 4.31).

The relative abundance of fishes in the littoral zone generally parallels the species composition data presented above. In mid June, the littoral zone was dominated by bluegill and pumpkinseed were moderately abundant. Lake herring, white sucker, golden shiner, fallfish, yellow bullhead, brown bullhead, rock bass, smallmouth bass, largemouth bass, and yellow perch were present, but relatively uncommon (Table 4.18).

Lake herring, rare in the trapnets, was the most abundant species in gillnet catches. The ratio of lake herring to lake trout was 3.7:1 (Table 4.18).

The overall Shannon diversity index was 2.39 and ranged from 2.12 (Site 7) to 2.49 (Site 2) for individual trapnet locations (Fig. 4.32).

With respect to species composition, sites 4 and 5 had the highest percentage similarity, sites 1, 6, and 7 formed a second group of similar locations, and site 2 had the lowest percentage similarity (Fig. 4.32).

Site 2 had the highest proportional abundance of white sucker and rock bass, but the lowest percentage of pumpkinseed, while the reverse was found at sites 1, 6, and 7. Sites 4 and 5 had an intermediate proportion of the above species compared to the sites at either extreme (Fig. 4.33, Table 4.17). Seventy percent of the total variation among the trapnet sites was explained by the differences between the locations defined above (Table 4.19).

Most of the remaining variation (20%) among the sites was the result of the percentage of brown bullhead caught at each location (Table 4.19). The relative abundance of brown bullhead ranged from a high at site 6 (12.8%) to a low at site 1 (0.7%) (Fig. 4.33, Table 4.17).

4.3.2 Population Characteristics

Lake trout - Lake trout age, fork length, and weight distributions from the 1981 winter sport fishery are depicted in Figures 4.34 - 4.36. The summer creel was conducted on a volunteer basis. As a result, no distributions from the summer sport fishery are available. Mean values from the 1981 winter creel census with 95% confidence limits are shown below.

Sample	Age (yr)	Total Length (cm)	Fork Length (cm)	Weight (g)
hatchery	5.2 ± 0.5	38.0 ± 3.3	34.6 ± 3.3	401 ± 139
native	4.9 ± 0.7	45.4 ± 7.9	42.1 ± 7.2	1021 ± 787
all	5.0 ± 0.4	42.2 ± 4.4	38.7 ± 4.0	733 ± 389

Ages in the winter sport fishery ranged from 3-7 years with the 1976 (age 5) year class the most abundant (Fig. 4.34).

Forty-six percent of the fish harvested were of hatchery origin.

The growth rate of lake trout in Big Salmon Lake is greater than expected for Ontario populations. Fork lengths-at-age were slightly greater than the standard growth curve for lake trout (MNR 1983). The growth index for the most abundant year class, age 5, was 113% and the mean growth index for all ages was 120% (Table 4.20). The instantaneous growth rate for lake trout was 0.153 ± 0.160, based on ages 3-7 (Fig. 4.37). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.21).

The total mortality rate for lake trout sampled during the winter creel was 0.50 based on ages 5-7 (Table 4.22). This is equivalent to the critical level of 0.50 for lake trout (MNR 1983).

Parasitic evaluations, based on a qualitative analysis from gillnets and spawning assessments, indicate that, externally, Salmincola, and internally, tapeworms, commonly affect lake trout living in Big Salmon Lake. Occurrences of fin rot, gill and intestinal flukes, popeye, and leech parasitism were incidental.

Lake trout in Big Salmon Lake appear to be primarily piscivorous. Stomach contents from 10 lake trout were examined. Eighty-seven percent of the food items were identified as fish products, 69% were sculpins, 19% were non-identifiable fish matter. Oppossum shrimp, made up the remaining 13% of the stomach contents. Three stomachs were empty.

Although lake trout were observed at three of five potential spawning shoals in 1980, only individual fish were noted. In 1981, however, another shoal with a substantial run was located (Table 4.23). Spawning depth was approximately 1 m. The mean age (7.7 ± 1.1 yr), mean fork length (68.6 ± 9.7 cm) and mean weight (4438 ± 2195 g) of four lake trout sampled during spawning was considerably greater than those sampled during the sport fishery. All four trout were native fish.

Smallmouth bass - The mean age of smallmouth bass captured in the trapnets was 4.1 ± 0.2 years, mean fork length was 20.1 ± 0.9 cm, and mean weight was 123 ± 24 g. Ages ranged from 3-7 years with the 1978, 1977, and 1976 year classes (ages 3, 4, and 5) the most abundant (Fig. 4.38).

The instantaneous growth rate was 0.192 ± 0.091 based on ages 3-7 (Fig. 4.37).

The smallmouth bass fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.21).

The total mortality rate for smallmouth bass (ages 3-7) taken in the trapnets was 0.56 (Table 4.22), exceeding the critical mortality rate (0.50) for smallmouth bass (MNR 1983).

Table 4.24 summarizes the percent occurrence of external parasites for target species sampled during trapnetting. Blackspot was the most common external parasite observed on smallmouth bass.

Largemouth bass - The mean age of the largemouth bass caught in the trapnets was 5.1 ± 0.4 years, mean fork length was 26.7 ± 1.7 cm, and mean weight was 413 ± 93 g. Ages ranged from 3-10 years with the 1975-1978 year classes (ages 3-6) the most abundant (Fig. 4.39).

The instantaneous growth rate was 0.132 ± 0.030, based on ages 2-9 (Fig. 4.37).

The parameters estimated from the Walford (L_∞=64.8, K=0.113) and von Bertalanffy (L_∞=64.8, K=0.122, t_0=0.556, ω'=7.9) analyses (Table 4.21, Fig. 4.40) indicate a higher growth rate than expected for Ontario populations. The estimate of L_∞ is approximately 20% greater than the maximum mean length-at-age reported for Ontario (Scott and Crossman 1973).

The total mortality rate of the largemouth bass sampled at Big Salmon Lake was 0.34, based on ages 4-10 (Table 4.22). Because a second peak in abundance occurred at age 6 (Fig. 4.39), the mortality rate was also calculated for ages 6-8 (0.65) (Table 4.22).

Blackspot was the most common external parasite observed on largemouth bass during trapnetting (Table 4.24).

Yellow perch - The mean age of the yellow perch captured in the trapnets was 4.4 ± 0.2 years, mean fork length was 19.0 ± 0.6 cm, and mean weight was 78 ± 11 g. Ages ranged from 3-8 years with the 1977 year class (age 4) the most abundant (Fig. 4.41).

The total mortality rate for the yellow perch trapnetted on Big Salmon Lake was 0.70 based on ages 4-7 (Table 4.22).

Blackspot and yellow grub were observed on approximately 20% of yellow perch sampled during trapnetting (Table 4.24).

Table 4.17 Species composition and total catch at Big Salmon Lake during June 17-26, 1981 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							Total Catch
	TN1	TN2	TN4	TN5	TN6	TN7	All Sites	
Lake herring	6.2	17.6	0.2			0.9	1.7	43
White sucker	2.7	20.4	14.9	10.6	4.0	5.8	9.9	244
Golden shiner					6.4	0.5	0.5	12
Fallfish			0.2				<0.1	1
Yellow bullhead			1.1	0.6		0.4	0.5	13
Brown bullhead	0.7	0.7	6.3	3.1	12.8	2.3	3.9	96
Rock bass	2.7	16.9	7.8	13.8	4.8	4.4	8.0	199
Pumpkinseed	26.0	4.9	12.4	11.7	21.6	17.5	14.8	367
Bluegill	45.2	32.4	46.5	51.7	44.0	57.1	50.3	1245
Smallmouth bass	1.4	0.7	1.8	4.9		4.7	3.3	82
Largemouth bass	2.7	2.1	4.1	1.8	4.8	4.3	3.5	87
Yellow perch	12.3	4.2	4.9	1.8	1.6	2.1	3.5	86
Total catch	146	142	656	549	125	857		247
Percent catch	5.9	5.7	26.5	22.2	5.1	34.6	100.0	

Table 4.18 CUE for fishes caught at Big Salmon Lake during 1981 by trapnet and gillnet. Blank denotes not present in net.

Species	Observed CUE by Gear type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Lake trout		5.0
Lake herring	0.8	18.5
White sucker	4.5	0.5
Golden shiner	0.2	
Fallfish	<0.1	
Yellow bullhead	0.2	
Brown bullhead	1.8	
Rock bass	3.7	
Pumpkinseed	6.8	
Bluegill	23.1	
Smallmouth bass	1.5	5.0
Largemouth bass	1.6	
Yellow perch	1.6	3.0

[1] total number of trapnet lifts = 54

[2] total number of gillnet lifts = 2

Table 4.19 First two principal compondents for the six most abundant species caught in trapnets on Big Salmon Lake, June 17-26, 1981.

Species	Principal Component	
	1	2
White sucker	0.59	0.17
Brown bullhead	-0.19	0.96
Rock bass	0.50	0.10
Pumpkinseed	-0.56	-0.09
Bluegill	-0.20	-0.01
Largemouth bass	-0.11	0.18
Percent variance	69.5	20.3
Cummulative variance	69.5	89.8

Table 4.20 Mean fork length-at-age (cm), 95% confidence limits, and growth indices[1] for fishes captured in Big Salmon Lake, 1981. Values in parentheses are sample sizes.

Species		Age III	IV	V	VI	VII	VIII	IX	X	Mean Growth Index
Lake trout	Mean	29.9 ± NA	34.9 ± 3.2	37.0 ± 4.5	35.6 ± 5.0	63.7 ± 17.4				
	GI	134 (1)	125 (7)	113 (12)	90 (4)	140 (3)				120
Smallmouth bass	Mean	16.9 ± 0.5 (22)	18.7 ± 0.6 (20)	22.2 ± 1.3 (15)	25.1 ± 6.6 (4)	38.1 ± NA (1)				
Largemouth bass	Mean	17.6 ± 1.1 (16)	21.6 ± 1.5 (18)	25.8 ± 0.9 (13)	31.3 ± 1.4 (12)	35.3 ± 2.1 (9)	39.6 ± 14.0 (2)	42.4 ± 3.8 (2)	43.3 ± 6.4 (3)	

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for lake trout (MNR 1983).

Table 4.21 Walford and Von Bertalanffy growth parameters for target species caught in Big Salmon Lake, 1981. Blank spaces indicate data which did not fit the Von Bertalanffy model.

Species	Ages	Walford L_{∞} (cm)	Walford K	Walford R^2	Von Bertalanffy L_{∞} (cm)	Von Bertalanffy K	Von Bertalanffy t_o	Von Bertalanffy ω	Von Bertalanffy R^2
Lake trout	3 - 7	10.9	-0.300	0.09					
Smallmouth bass	3 - 7	16.2	-0.778	0.88					
Largemouth bass	3 - 10	64.8	0.113	0.98	64.8	0.122	0.556	7.9	0.99

[1] $\omega = K \times L_{\infty}$ (Gallucci and Quinn 1979, based on a linear regression of $Ln(L_{\infty} - L_t)$ against age.

Table 4.22 Total mortality rates for target species captured on Big Salmon Lake in 1981. Lake trout estimates are from winter creel census, other species from trapnet data.

Species	Mortality Rate	Confidence Interval	Ages
Lake trout	0.50	0.00 - 0.97	5 - 7
Smallmouth bass	0.56	0.11 - 0.78	3 - 7
Largemouth bass	0.34	0.14 - 0.49	4 - 10
	0.65	0.00 - 1.00	6 - 8
Yellow perch	0.70	0.22 - 0.88	4 - 7

Table 4.23 The number of lake trout observed during spawning investigations at 6 shoals on Big Salmon Lake, 15 October - 27 November, 1981.
Blank spaces denote missing data due to weather or logistical constraints.

	Shoal					
Date	1	2	3	4	5	6
October 15	0	0	0	0	0	20
October 21					0	1
October 24	0	0	0/0	0	0	4
October 27	0	0	0	0	0	0

#/# denotes 2 observations on same night.

Table 4.24 The percent occurrence of visible external parasites for target species sampled during trapnetting in Big Salmon Lake, June 17-26, 1981.
Blank spaces denote that no parasites were observed.

Species	No.	Parasite	
		Blackspot	Yellow grub
Smallmouth bass	67	46	
Largemouth bass	77	44	8
Yellow perch	56	21	23

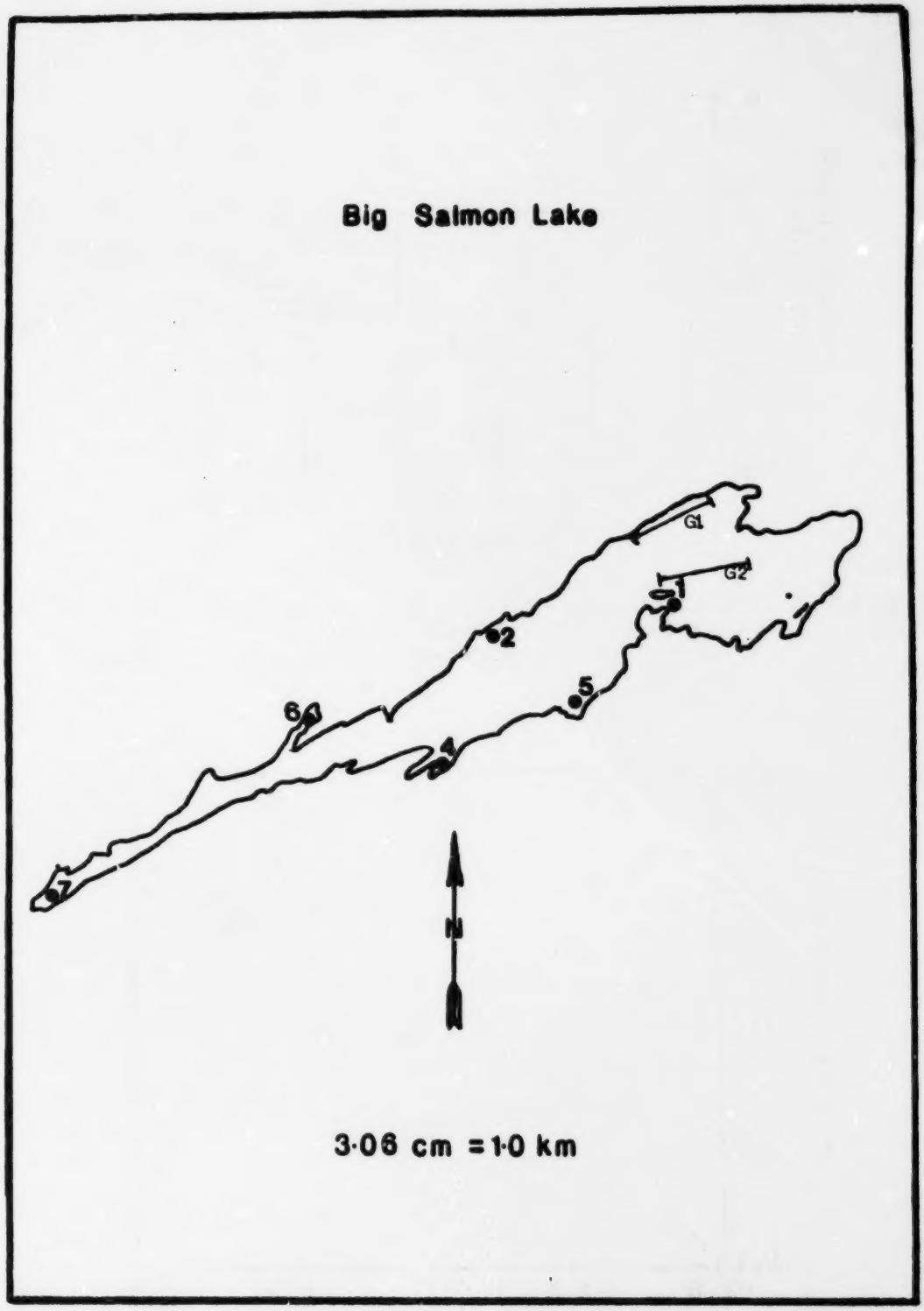


Figure 4.31 Index netting gear locations on Big Salmon Lake, 1981.

● = trapnet location.
⟝⟞ = gillnet location.

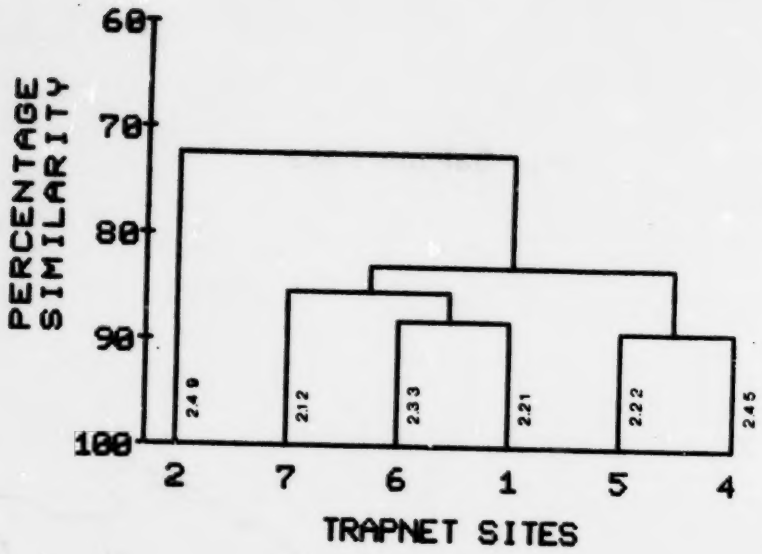


Figure 4.32 The percentage similarity between the trapnet sites on Big Salmon Lake, June 17-26, 1981. The number next to each cluster is the diversity index for the respective sites.

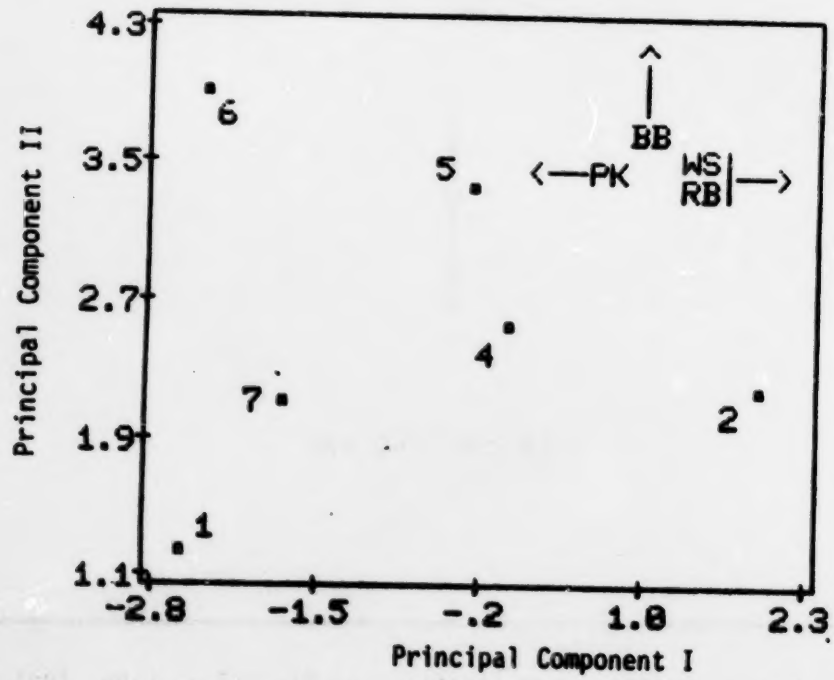


Figure 4.33 The major differences in species composition between the Big Salmon Lake trapnet sites, June 17-26, 1981. With respect to each axis (principal component), the arrows indicate the direction of increasing proportional abundance of the designated species.
PK, pumpkinseed; BB, brown bullhead; WS, white sucker; RB, rock bass.

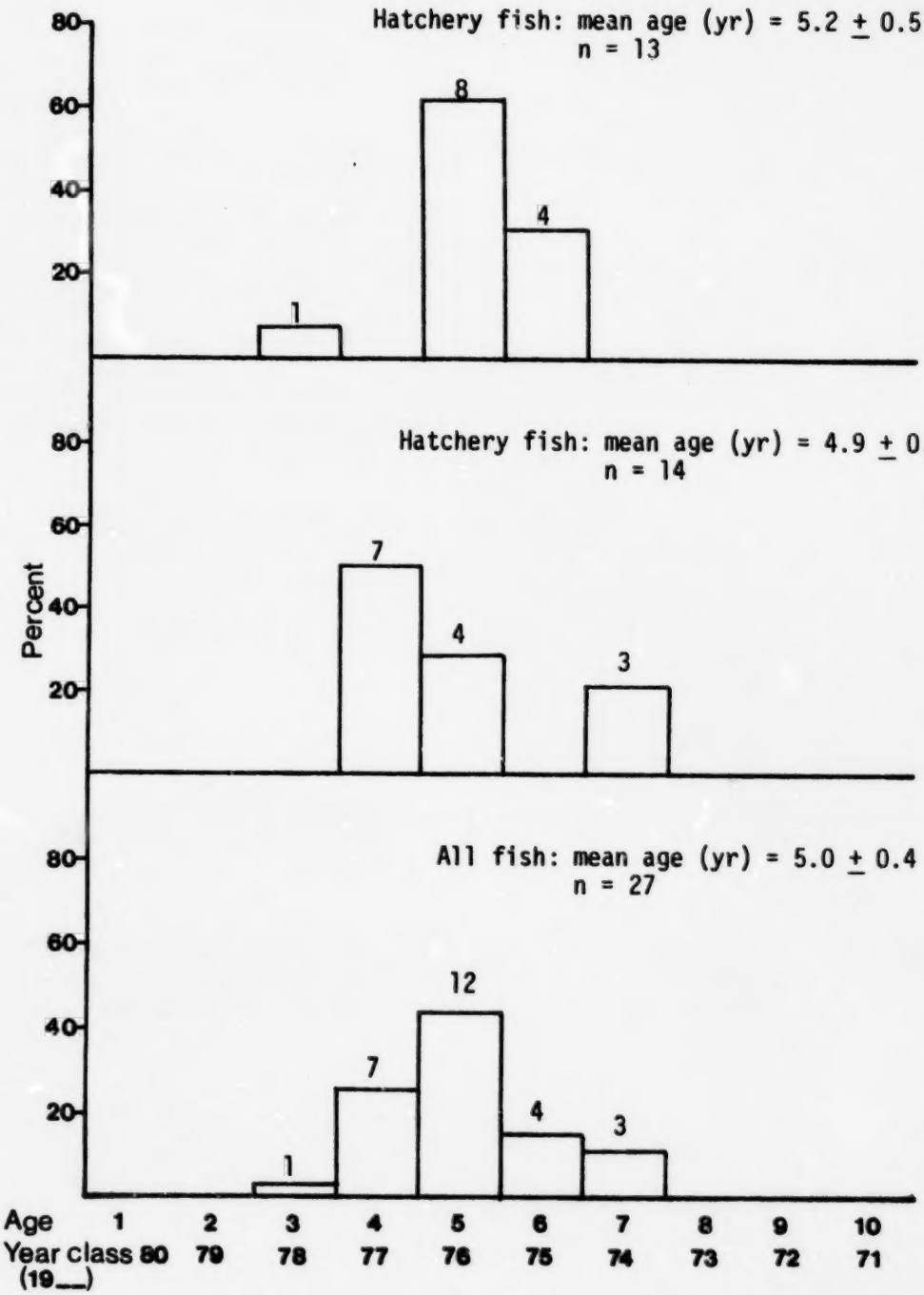


Figure 4.34 Age distributions of lake trout sampled during the winter 1981 sport fishery on Big Salmon Lake. Numbers over each bar indicate actual count frequencies.

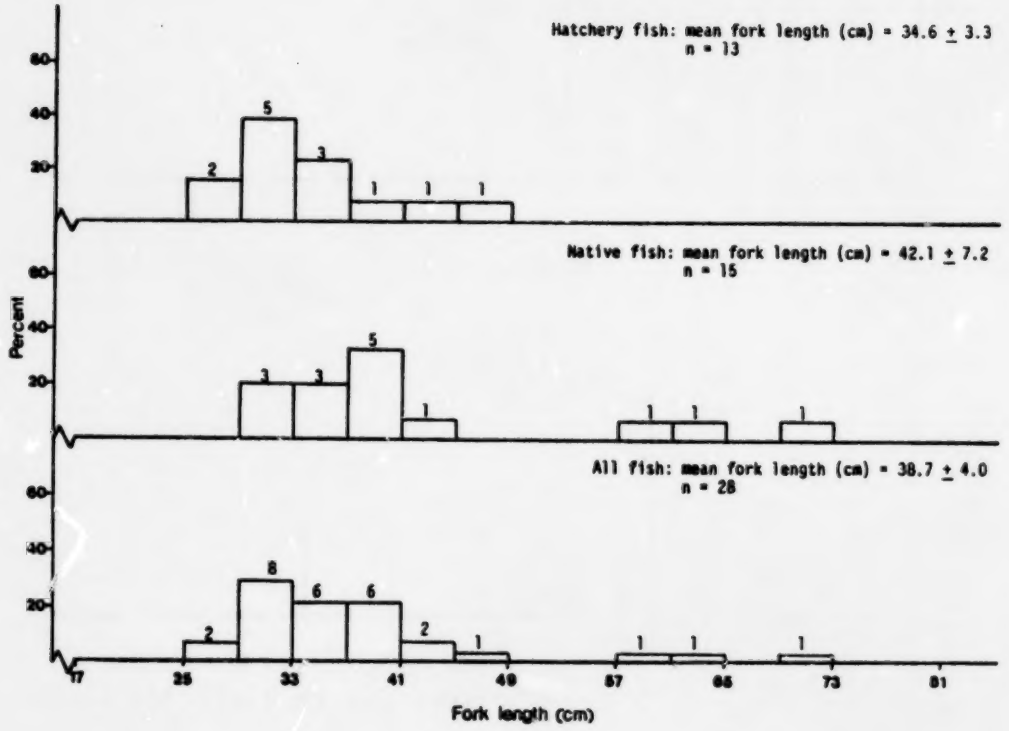


Figure 4.35 Fork length distributions of lake trout sampled during the winter 1981 sport fishery on Big Salmon Lake. Numbers over each bar indicate actual count frequencies.

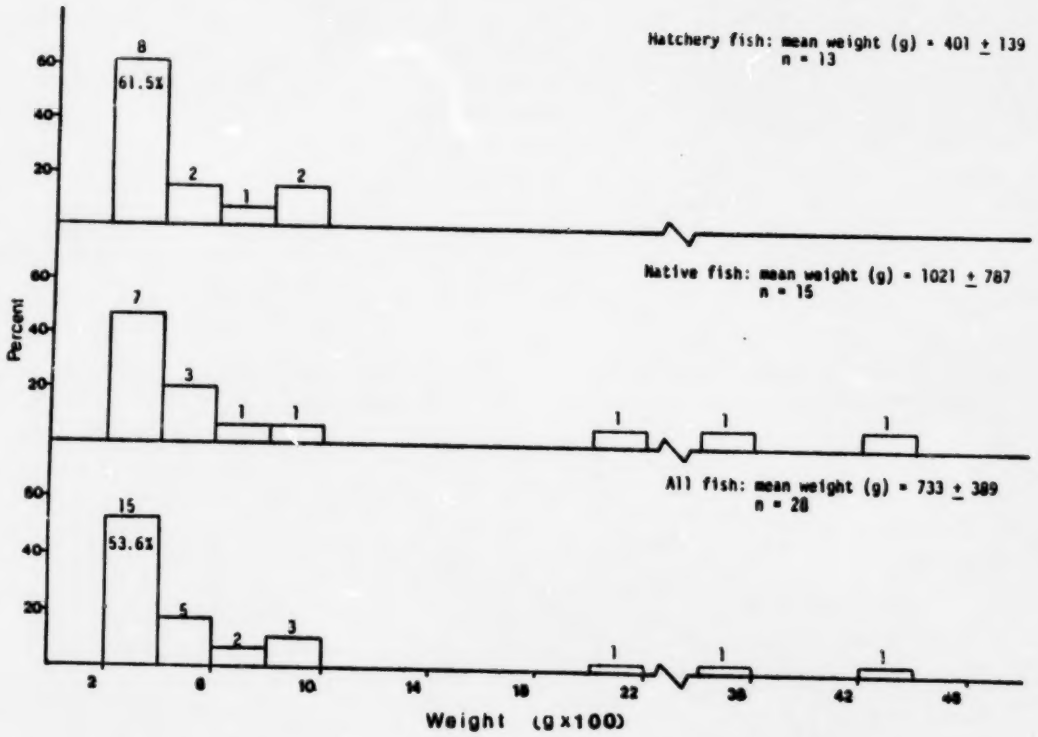

Hatchery fish: mean weight (g) = 401 ± 139
n = 13
Native fish: mean weight (g) = 1021 ± 787
n = 15
All fish: mean weight (g) = 733 ± 389
n = 28
Percent
Weight (g x100)
61.5%
53.6%

Figure 4.36 Weight distributions of lake trout sampled during the winter 1981 sport fishery on Big Salmon Lake. Numbers over each bar indicate actual count frequencies.

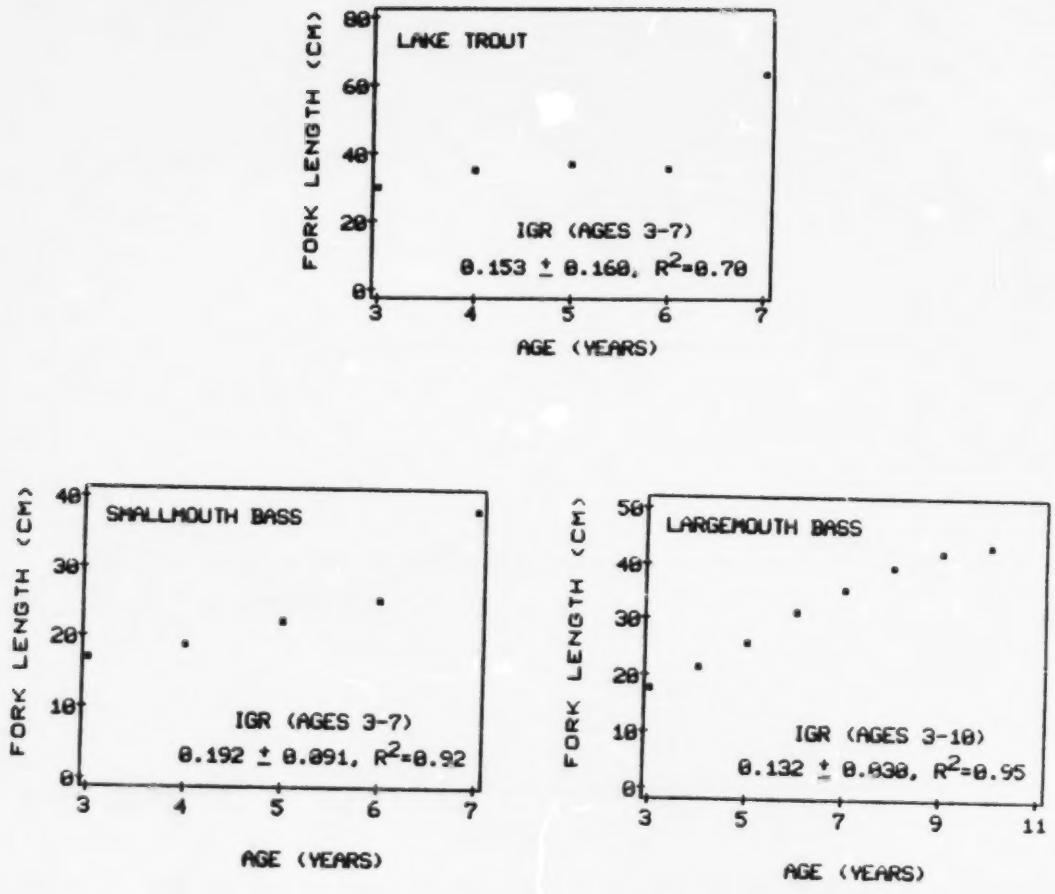
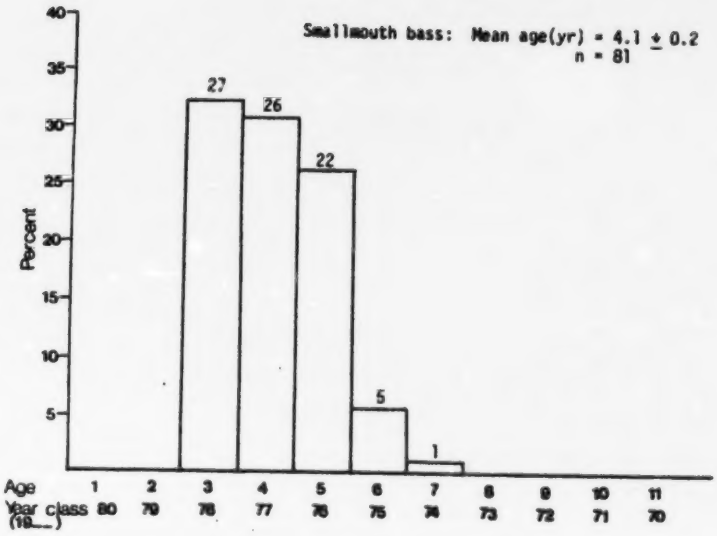
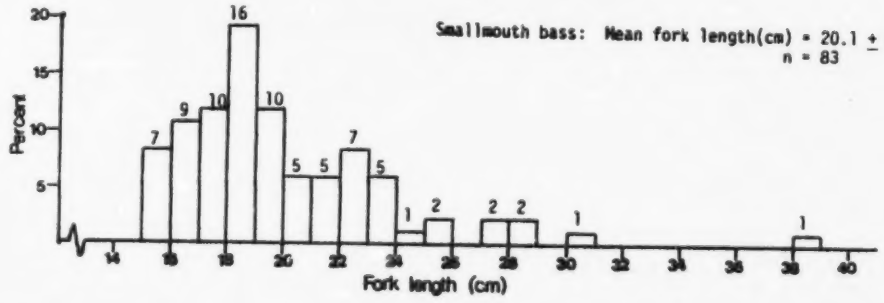


Figure 4.37 Absolute growth rate of lake trout, smallmouth bass and largemouth bass, sampled at Big Salmon Lake, 1981. Lake trout were sampled during the winter 1981 creel census. The other target species were sampled during the index trapnetting, June 17-26, 1981. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.





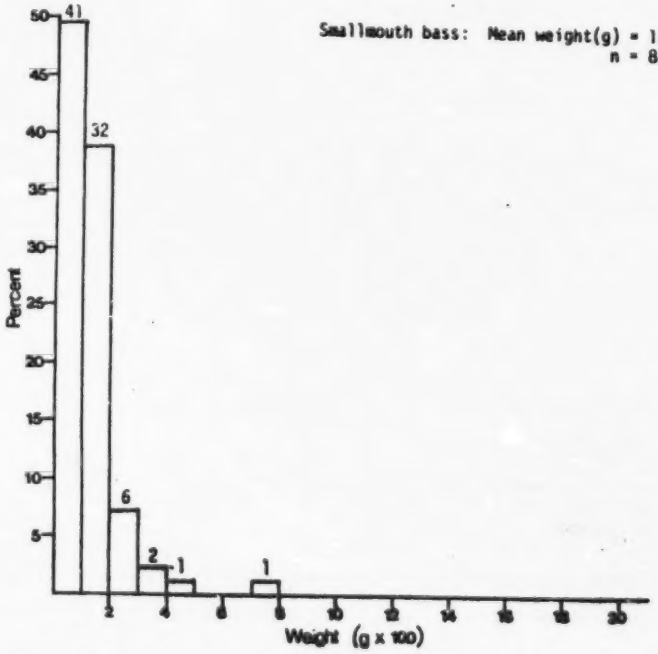
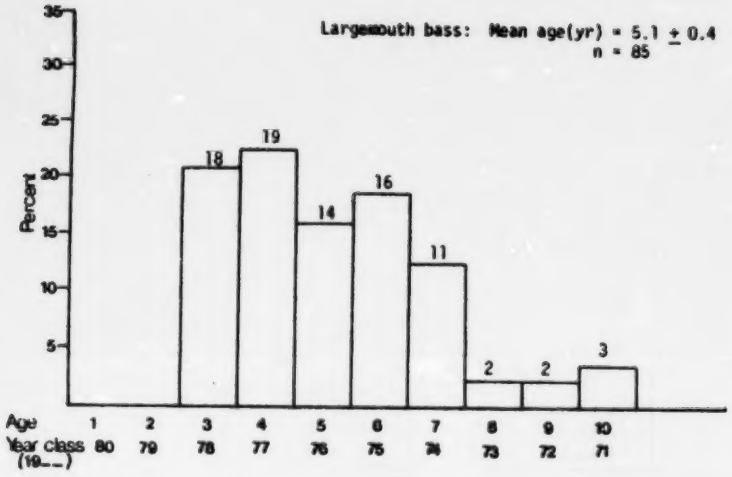
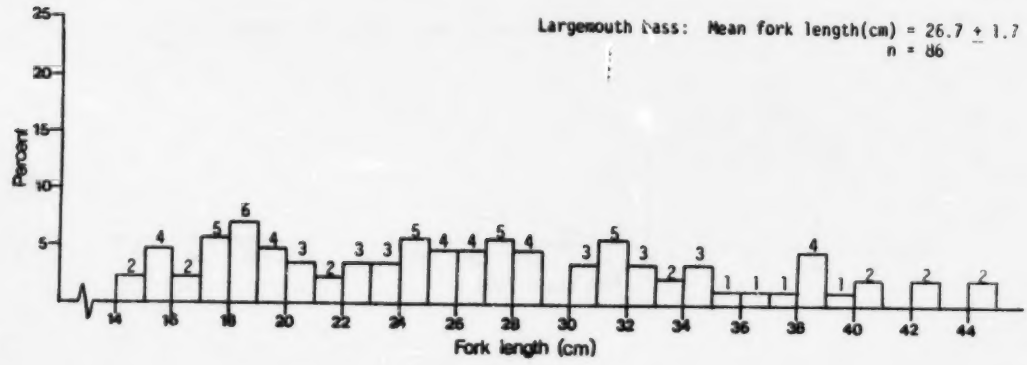


Figure 4.38 Age, fork length, and weight distributions for smallmouth bass captured in trapnets on Big Salmon Lake, June 7-26, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.





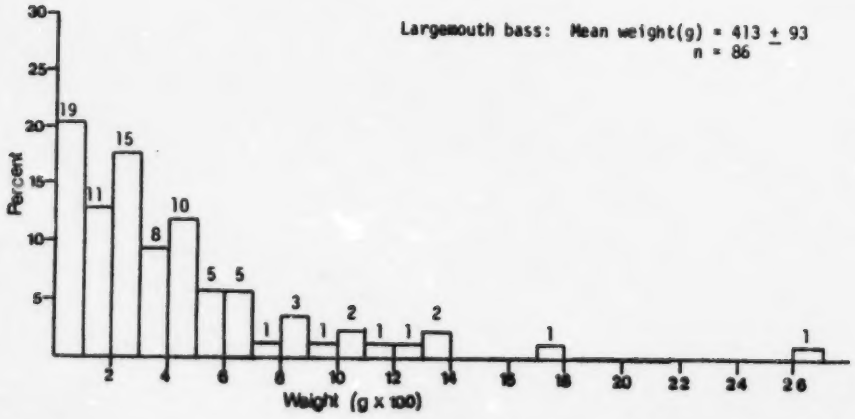
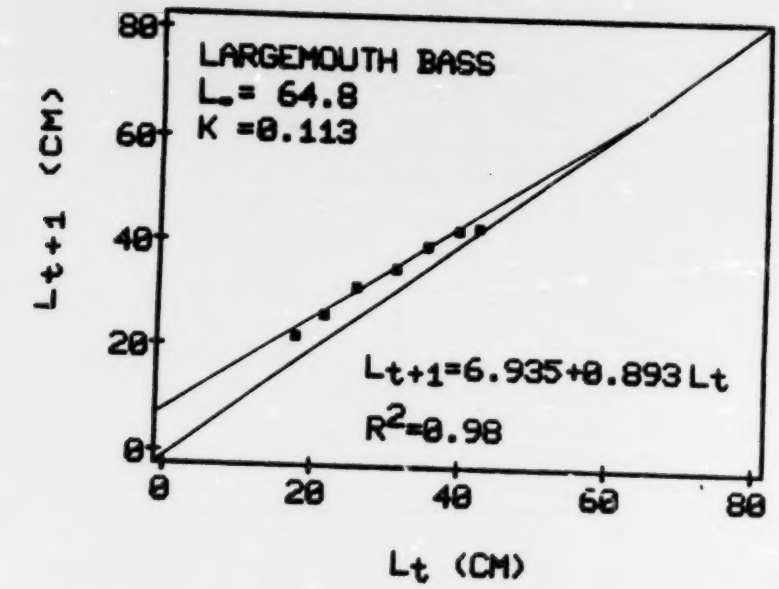


Figure 4.39 Age, fork length, and weight distributions of largemouth bass captured in trapnets on Big Salmon Lake, June 17-26, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.



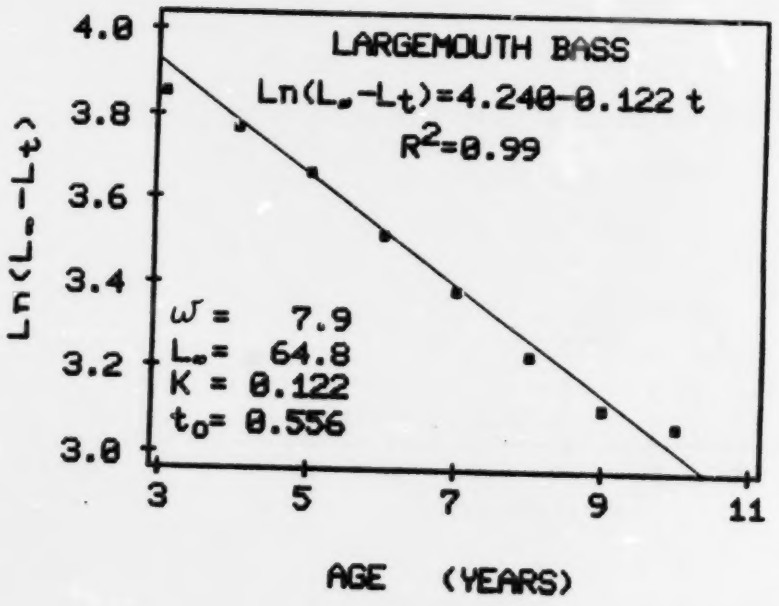


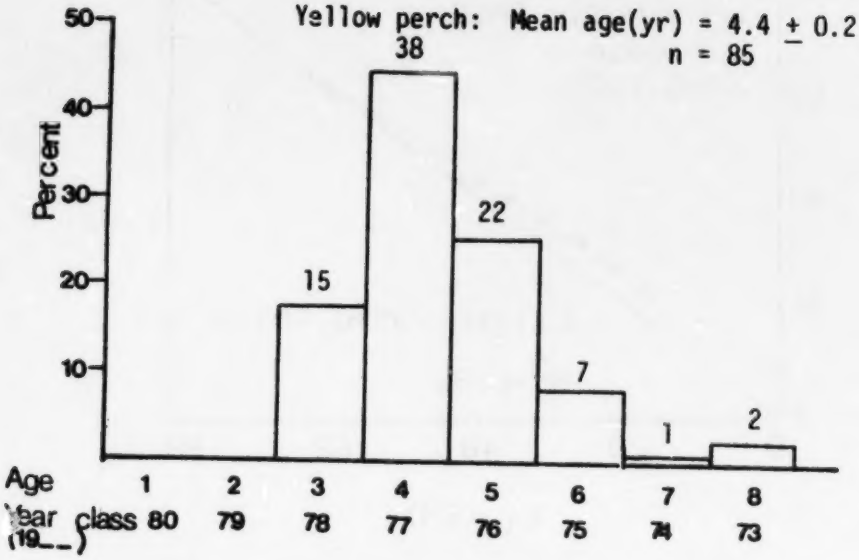
Figure 4.40 Walford, L_{t+1} against L_t, and von Bertalanffy, $Ln(L_\infty - L_t)$ against age, plots, based on mean lengths (cm) at age for largemouth bass captured in Big Salmon Lake, June 17-26, 1981.

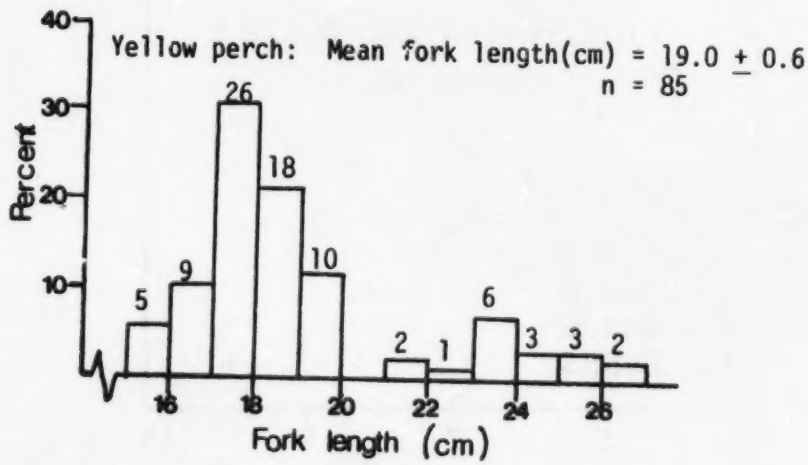
L_∞ is the ultimate length (cm) of the population.

K is the growth coefficient.

t_0 is the time when length is theoretically zero.

$\omega = K \times L_\infty$ (Galluci and Quinn 1979, based on linear regression).





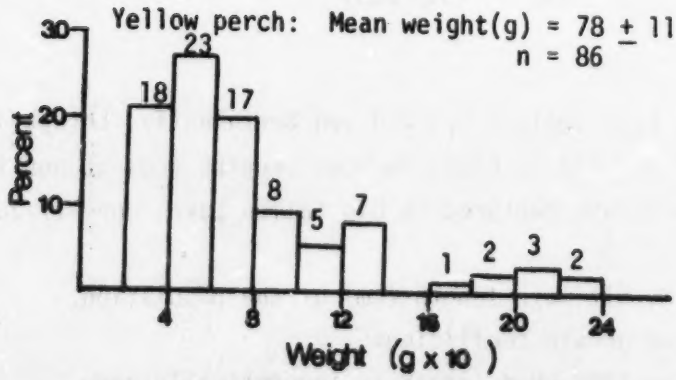


Figure 4.41 Age, fork length, and weight distributions of yellow perch captured in trapnets on Big Salmon Lake, July 17-26, 1981. Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

4.4 CHARLESTON LAKE

4.4.1 Community Structure

Species composition and diversity - Brown bullhead comprised the greatest percentage of the catch (40.7%), followed by bluegill (28.5%), pumpkinseed (9.6%), yellow perch (8.8%), rock bass (3.8%), largemouth bass (1.9%), yellow bullhead (1.8%), black crappie (1.5%), smallmouth bass (1.1%), and northern pike (1.0%). Alewife, lake trout, white sucker, golden shiner, and American eel each made up <1% of the catch. Most of the fish were caught at trapnet sites 1 and 4 (Table 4.25, Figure 4.42).

The relative abundance of fishes in the littoral zone generally parallels the species composition data presented above. In late May, the littoral zone was dominated by brown bullhead. Pumpkinseed, bluegill, and yellow perch were moderately abundant. Alewife, lake trout, northern pike, white sucker, golden shiner, yellow bullhead, American eel, rock bass, smallmouth bass, largemouth bass, and black crappie were present but relatively uncommon (Table 4.26).

Lake herring, absent in the trapnets, was the most abundant species in the gillnet catches. Alewife was the second most abundant species caught in the gillnets. The ratio of lake herring to lake trout was 3.8:1. The ratio of alewife to lake trout was 2.5:1 (Table 4.26).

The overall diversity index was 2.39 and ranged from 1.91 (Site 1) to 2.84 (Site 3) for individual trapnet locations (Fig. 4.43).

With respect to species composition, sites 2 and 4 had the highest percentage similarity, sites 3 and 5 formed a second group of similar trapnet locations, and sites 1 and 6 were the most dissimilar (Fig. 4.43).

Sites 3 and 5 differed from all other locations (sites 1, 2, 4, and 6) in having a greater relative abundance of yellow perch and pumpkinseed but a lower combined percentage of brown bullhead and bluegill (Fig. 4.44, Table 4.25). Sixty percent of the total variation among the trapnet sites was explained by the differences between the locations described above (Table 4.27).

The dissimilarity of sites 1 and 6, from each other, and sites 2 and 4, was a result of the percentage of brown bullhead and bluegill caught in these nets (Table 4.27). With respect to sites 1, 2, 4, and 6, the proportion of brown bullhead ranged from a high at site 1 (62.3%) and a low at site 6 (19.4%), while bluegill ranged from a low at site 1 (19.1%) to a high at site 6 (50.6%) (Fig. 4.44, Table 4.25). Thirty-two percent of the variation among the trapnet sites was explained by the contrast in brown bullhead and bluegill abundances described above (Table 4.27).

4.4.2 Population Characteristics

Lake trout - Lake trout age, fork length, and weight distributions from the 1981 winter and summer sport fisheries are depicted in Figures 4.45- 4.50 . Mean values with 95% confidence limits are shown below.

Sample	Age (yr)	Total Length (cm)	Fork Length (cm)	Weight (g)
Winter				
hatchery	4.3 ± 0.4	37.7 ± 3.7	34.6 ± 3.4	583 ± 218
native	5.5 ± 0.3	48.8 ± 3.5	45.0 ± 3.3	1284 ± 335
all	4.8 ± 0.3	42.8 ± 2.9	39.3 ± 2.7	901 ± 205
Summer				
hatchery	4.5 ± 0.4	44.6 ± 3.3	41.0 ± 3.0	886 ± 207
native	5.1 ± 0.4	53.1 ± 3.6	48.5 ± 3.8	1587 ± 431
all	4.8 ± 0.3	49.0 ± 2.6	44.9 ± 2.5	1272 ± 247

Ages in the winter sport fishery ranged from 2-7 years with the 1975 (age 6) year class the most abundant (Fig. 4.45). Ages in the summer sport fishery ranged from 3-8 years with the 1976 (age 5) year class the most abundant (Fig. 4.48).

Fifty-six percent of the lake trout harvested during the winter fishery and 48% of those harvested during the summer were of hatchery origin.

The growth rate of lake trout in Charleston Lake is greater than expected for Ontario populations. Fork lengths-at-age (Table 4.28) were much greater than the standard growth curve for lake trout (MNR 1983). The growth index for the most abundant year class, age 6, was 132% and the mean growth index for all ages was 123% (Table 4.28). The instantaneous growth rate for lake trout was 0.220 + 0.021 based on ages 2-8 (Fig. 4.51). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.29).

The total mortality rate for lake trout sampled during the summer creel was 0.65 based on ages 5-8 (Table 4.30). This is well above the critical level of 0.50 for lake trout (MNR 1983).

Parasitic evaluations, based on a qualitative analysis of lake trout from summer creel, gillnets, and spawning assessments, indicate that, externally, Salmincola, and internally, tapeworms, commonly affect lake trout living in Charleston Lake. Occurrences of fin rot, gill and intestinal flukes, and leech parasitism were incidental.

Lake trout in Charleston Lake appear to be primarily piscivorous. Stomach contents from 15 lake trout were examined. Seventy-seven percent of the food items were identified as fish products, 48% were alewives, 24% were herring, and 5% were non-identifiable fish species. Nineteen percent were opposum shrimp and 5% percent were non-identifiable invertebrates. Two stomachs were empty.

Substantial spawning runs were observed at five of the six

potential spawning shoals monitored (Table 4.31). Most spawning occurred at 1.0-2.0 m. American eels were observed at most spawning locations (a total of 75 over the period). However, we were unable to capture any for stomach content analysis. The mean age (6.6 ± 0.2 yr), mean fork length (62.7 ± 1.6 cm), and mean weight (3074 ± 304 g) of 51 spawning lake trout were considerably greater than those of lake trout caught in the sport fishery (Fig. 4.52). Only 3.9% of these spawning lake trout were of hatchery origin.

Northern pike - The mean age of northern pike captured in the trapnets was 3.2 ± 0.3 years, mean fork length was 52.4 ± 2.3 cm, and mean weight was 1293 ± 169 g. Ages ranged from 1-7 years with the 1979 (age 2) year class the most abundant (Fig. 4.53).

The growth rate of Charleston Lake northern pike is slightly greater than that expected for Ontario populations with a mean growth index of 118% (Table 4.28). The instantaneous growth rate was 0.127 ± 0.035 based on ages 2-8 (Fig. 4.51). The parameters estimated from the Walford (L_∞=95.8, K=0.179) and von Bertalanffy (L_∞=103.8, K=0.155, t_o=-1.456, w'=16.1) analyses (Table 4.29, Fig. 4.54) are very similar to those calculated from 18 sets of Ontario data (L_∞=98.31, K=0.145, t_o=-1.122, w'=14.27) (MNR 1983).

The total mortality rate of the northern pike sampled in the trapnets was 0.38 based on ages 2-7 (Table 4.30). Because a second peak in abundance occurred at age 5 (Fig. 4.53), the mortality rate was also calculated for ages 2-4 (0.38) and 5-7 (0.61) (Table 4.30). These rates are below the critical level (0.65) for northern pike (MNR 1983).

Table 4.32 summarizes the percent occurrence of external parasites for target species sampled during trapnetting. Redsore was the most common parasitic condition observed on northern pike.

Smallmouth bass - The mean age of smallmouth bass caught in the trapnets was 6.4 ± 0.3 years, mean fork length was 30.8 ± 1.1 cm, and mean weight was 627 ± 83 g. Ages ranged from 3-11 with the 1975 (age 6) year class the most abundant (Fig. 4.55). The instantaneous growth rate was 0.096 ± 0.017 based on ages 3-11 (Fig. 4.51).

The fork-length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.29).

The total mortality rate for smallmouth bass taken in the trapnets was 0.38 based on ages 6-11 (Table 4.30). This rate is below the critical level (0.50) for smallmouth bass (MNR 1983). Seventy percent of the sport fishery catch was in the age 6-10 interval (MacLean and Schlesinger 1982). Therefore, the mortality rate determined from trapnet data is representative of the population's response to 1981 effort levels.

Blackspot was the only external parasite observed on smallmouth bass during trapnetting (Table 4.32).

Largemouth bass - The mean age of the largemouth bass captured in the trapnets was 6.0 ± 0.3 years, mean fork length

was 29.8 ± 1.1 cm, and mean weight was 792 ± 62 g. Ages ranged from 2-13 years with the 1975 (age 6) year class the most abundant (Fig. 4.56).

The instantaneous growth rate was 0.140 ± 0.015 based on ages 2-9 (Fig. 4.51).

While the Walford and von Bertalanffy growth parameter estimates are statistically acceptable, they are unrealistic (Table 4.29).

The total mortality rate of the largemouth bass sampled on Charleston Lake was 0.34 based on ages 6-13 (Table 4.30). Seventy-two percent of the sport fishery catch was in the 6-13 age interval (MacLean and Schlesinger 1982). Therefore, the mortality rate determined from trapnet data is representative of the population's response to 1981 effort levels.

Blackspot was the most common parasite observed on largemouth bass during trapnetting (Table 4.32).

Yellow perch - The mean age of yellow perch caught in the trapnets was 5.7 ± 0.3 years, mean fork length was 20.5 ± 0.5 cm, and mean weight was 169 ± 9 g. Ages ranged from 3-10 years with the 1975 (age 6) year class the most abundant (Fig. 4.57).

The instantaneous growth rate was 0.082 ± 0.015 based on ages 3-10 (Fig. 4.51).

The total mortality rate for yellow perch sampled in the trapnets on Charleston Lake could not be calculated as a result of an atypical catch curve (Fig. 4.57).

Yellow grub was the only parasite observed on yellow perch during trapnetting (Table 4.32).

Table 4.25 Species composition and total catch at Charleston Lake during June 3-12, 1981 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							Total Catch
	TN1	TN2	TN3	TN4	TN5	TN6	All Sites	
Alewife	0.1	0.3	0.0	0.6	0.0	0.4	0.3	30
Lake trout			0.2				<0.1	1
Northern pike	0.3	0.3	5.4	1.1	1.0	1.4	1.0	104
White sucker	0.2	0.1	0.5	0.2	0.6	0.1	0.2	25
Golden shiner	<0.1					<0.1	<0.1	2
Yellow bullhead	1.4	3.9		2.4	0.8	0.6	1.8	188
Brown bullhead	62.3	42.4	24.6	47.7	19.9	19.4	40.7	4296
American eel	0.3	0.7	6.8	0.9	0.3	0.9	0.8	87
Rock bass	2.4	3.3	9.0	3.1	5.5	4.8	3.8	406
Pumpkinseed	7.5	9.2	26.0	5.3	15.9	8.7	9.6	1010
Bluegill	19.1	34.2	5.4	28.1	22.2	50.6	28.5	3006
Smallmouth bass	0.8	0.3	7.1	0.8	2.3	0.4	1.1	120
Largemouth bass	1.5	2.0	1.5	2.7	1.2	2.1	1.9	201
Black crappie	1.2	1.8		1.5	0.1	3.3	1.5	156
Yellow perch	2.9	1.4	13.6	5.6	30.3	7.4	8.8	932
Total catch	2595	1796	411	2440	1732	1590		10564
Percent catch	24.6	17.0	3.9	23.1	16.4	15.1	100.0	

Table 4.26 CUE for fishes caught at Charleston Lake during 1981 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Alewife	0.6	40
Lake trout	<0.1	16
Lake herring		61
Northern pike	2.2	
White sucker	0.5	
Golden shiner	<0.1	
Yellow bullhead	3.9	
Brown bullhead	89.5	
American eel	1.8	
Burbot		1
Rock bass	8.5	
Pumpkinseed	21.0	
Bluegill	62.6	
Smallmouth bass	2.5	1
Largemouth bass	4.2	
Black crappie	3.3	
Yellow perch	19.4	

[1] total number of trapnet lifts = 48

[2] total number of gillnet lifts = 1

Table 4.27 First two principal components for the six most abundant species caught in trapnets on Charleston Lake, May 20-29, 1981.

Species	Principal Component	
	1	2
Brown bullhead	0.49	-0.54
Rock bass	-0.20	-0.01
Pumpkinseed	-0.41	-0.16
Bluegill	0.41	0.80
Smallmouth bass	0.05	0.02
Yellow perch	-0.61	0.21
Percent variance	59.8	32.4
Cummulative variance	59.8	92.2

Table 4.28 Mean fork length-at-age (cm), 95% confidence limits and growth indices[1] for fishes captured in Charleston Lake, 1981. Values in parentheses are sample sizes.

Species		Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Lake trout	Mean		19.6±17.8	25.6±1.1	32.3±3.4	38.2±1.1	52.4±2.4	61.5±2.5	72.3±6.3					
	GI		108	115	116	116	132	135	141					123
			(2)	(8)	(9)	(17)	(31)	(13)	(6)					
Northern pike	Mean	33.6±3.3	45.7±2.2	53.4±2.4	55.9±3.7	61.9±3.7	71.2±3.8	78.0±22.2						
	GI	146	123	115	106	108	114	117						118
		(9)	(32)	(25)	(13)	(12)	(8)	(2)						
Smallmouth bass	Mean			20.1±NA	23.6±2.4	25.9±0.9	28.2±0.8	34.6±2.3	36.6±1.9	38.2±1.0	40.3±11.7	43.5±5.4		
				(1)	(6)	(22)	(30)	(14)	(10)	(5)	(3)	(3)		
Largemouth bass	Mean		15.5±NA	18.5±1.1	22.4±1.2	25.1±1.1	29.7±1.0	33.7±2.3	37.5±1.0	41.0±1.6		40.7±6.1	46.6±2.4	
			(1)	(11)	(15)	(14)	(22)	(8)	(12)	(6)		(4)	(3)	
Yellow perch	Mean			15.7±0.4	17.1±0.6	20.1±0.6	21.2±0.6	23.5±1.4	25.0±0.9	26.7±2.1	27.4±1.0			
				(8)	(25)	(22)	(63)	(17)	(20)	(8)	(10)			

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for lake trout and northern pike (MNR 1983).

Table 4.29 Walford and Von Bertalanffy growth parameters for target species caught in Charleston Lake, 1981. Blank spaces indicate data which did not fit the Von Bertalanffy model.

Species	Ages	Walford L_{∞} (cm)	Walford K	Walford R^2	Von Bertalanffy L_{∞} (cm)	Von Bertalanffy K	Von Bertalanffy t_0	Von Bertalanffy ω	Von Bertalanffy R^2
Lake trout	2 - 8	38.7	-0.108	0.98					
Northern pike	1 - 7	95.8	0.179	0.94	103.8	0.155	-1.456	16.1	0.98
Smallmouth bass	4 - 9	58.6	0.107	0.88					
Largemouth bass	2 - 13	236.9	0.097	0.97	236.9	0.014	-3.184	3.3	0.96

[1] $\omega = K \times L_{\infty}$ (Gallucci and Quinn 1979), based on a linear regression of $Ln(L_{\infty} - L_t)$ against age.

Table 4.30 Total mortality rates for target species captured on Charleston Lake, 1981. Lake trout estimates are from summer creel census, other species from trapnet data.

Species	Mortality Rate	Confidence Interval	Ages
Lake trout	0.65	0.62 - 0.68	5 - 8
Northern pike	0.38	0.20 - 0.53	2 - 7
	0.38	0.00 - 0.91	2 - 4
	0.61	0.00 - 0.99	5 - 7
Smallmouth bass	0.38	0.28 - 0.47	6 - 11
Largemouth bass	0.34	0.05 - 0.54	6 - 13

Table 4.31 The number of lake trout observed during spawning investigations at 6 shoals on Charleston Lake, 13 October - 28 October, 1981.
Blank spaces denote missing data due to weather or logistical constraints.

	Shoal					
Date	4	5	6	7	8	9
October 13		3	6	7	27	
October 14		4	28	12	26	15
October 16		4	2/12	16	35	17
October 27		0			17	0
October 28	0	8	2	0	3	1

#/# denotes 2 observations on same night.

Table 4.32 The percent occurrence of visible external parasites for target species sampled during trapnetting in Charleston Lake, May 20-29, 1981.
Blank spaces denote that no parasites were observed.

		Parasite		
Species	No.	Blackspot	Red sore	Yellow grub
Northern pike	101	39	51	
Smallmouth bass	108	29		
Largemouth bass	192	39		3
Yellow perch	175			2

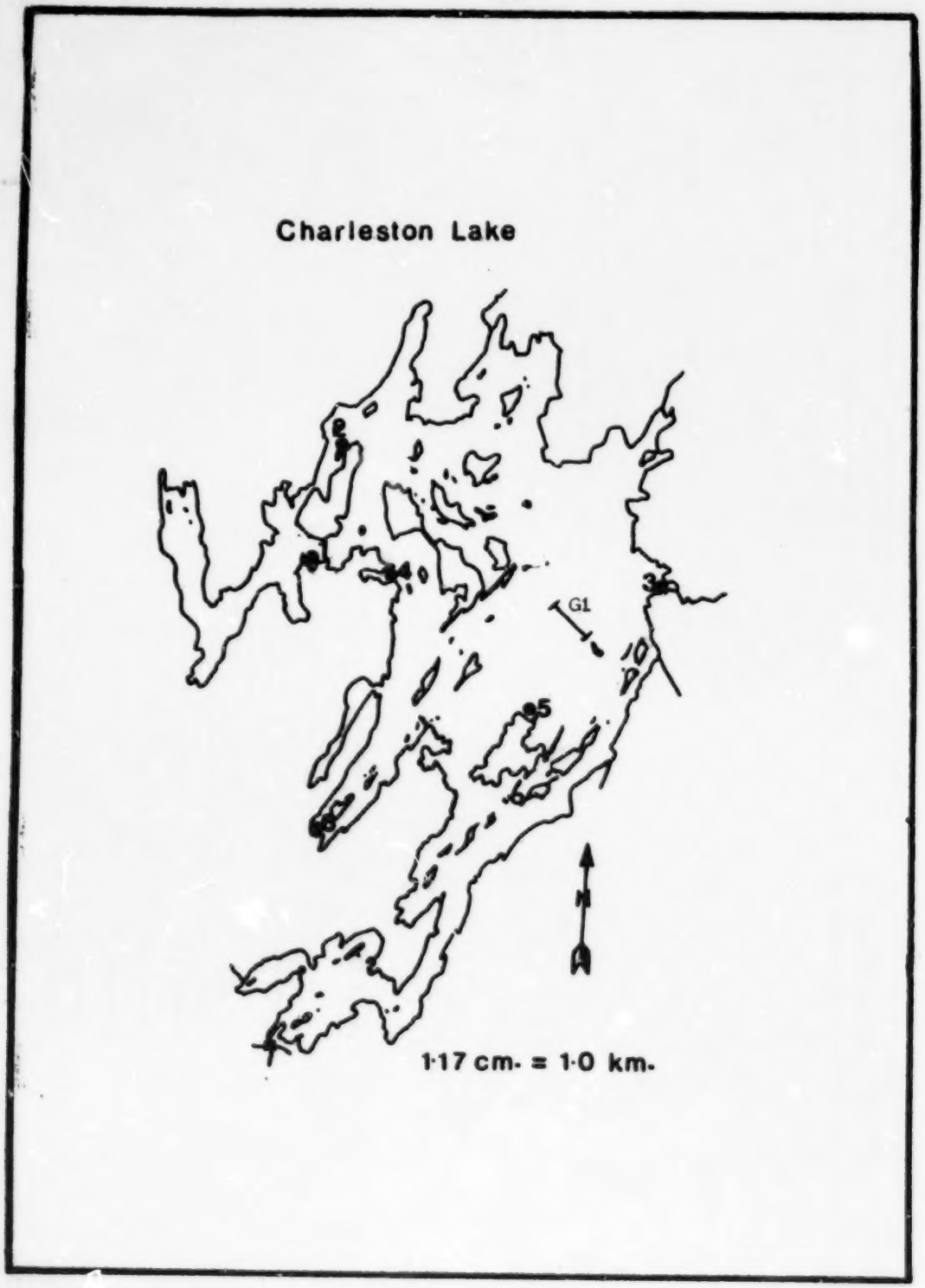


Figure 4.42 Index netting gear locations on Charleston Lake, 1981.

● = trapnet location.
⟵⟶ = gillnet location.

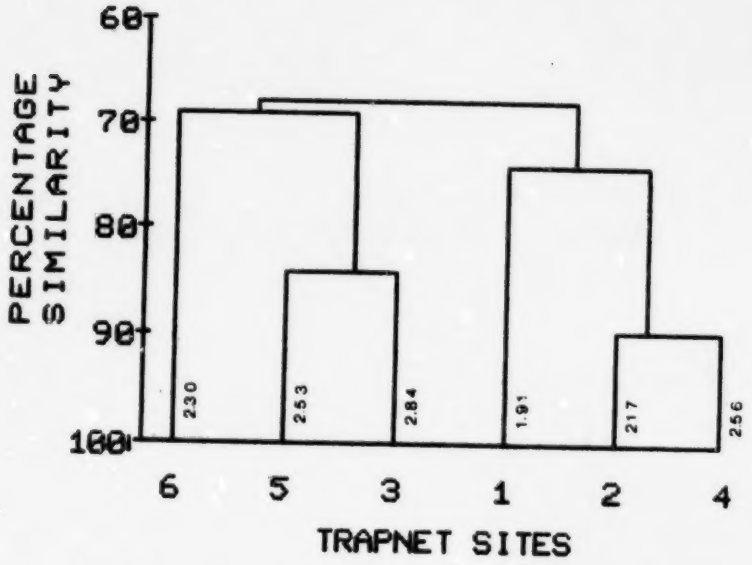


Figure 4.43 The percentage similarity between the trapnet sites on Charleston Lake, May 20-29, 1981. The number next to each cluster is the diversity index for the respective sites.

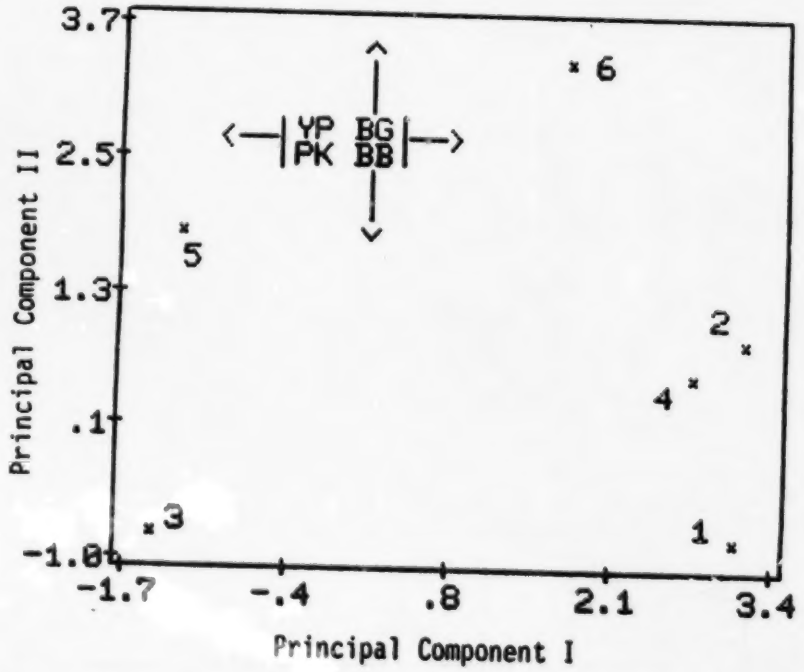


Figure 4.44 The major differences in species composition between the Charleston Lake trapnet sites, May 20-29, 1981. With respect to each axis (principal component), the arrows indicate the direction of increasing proportional abundance of designated species.
YP, yellow perch; PK, pumpkinseed; BG, bluegill; BB, brown bullhead.

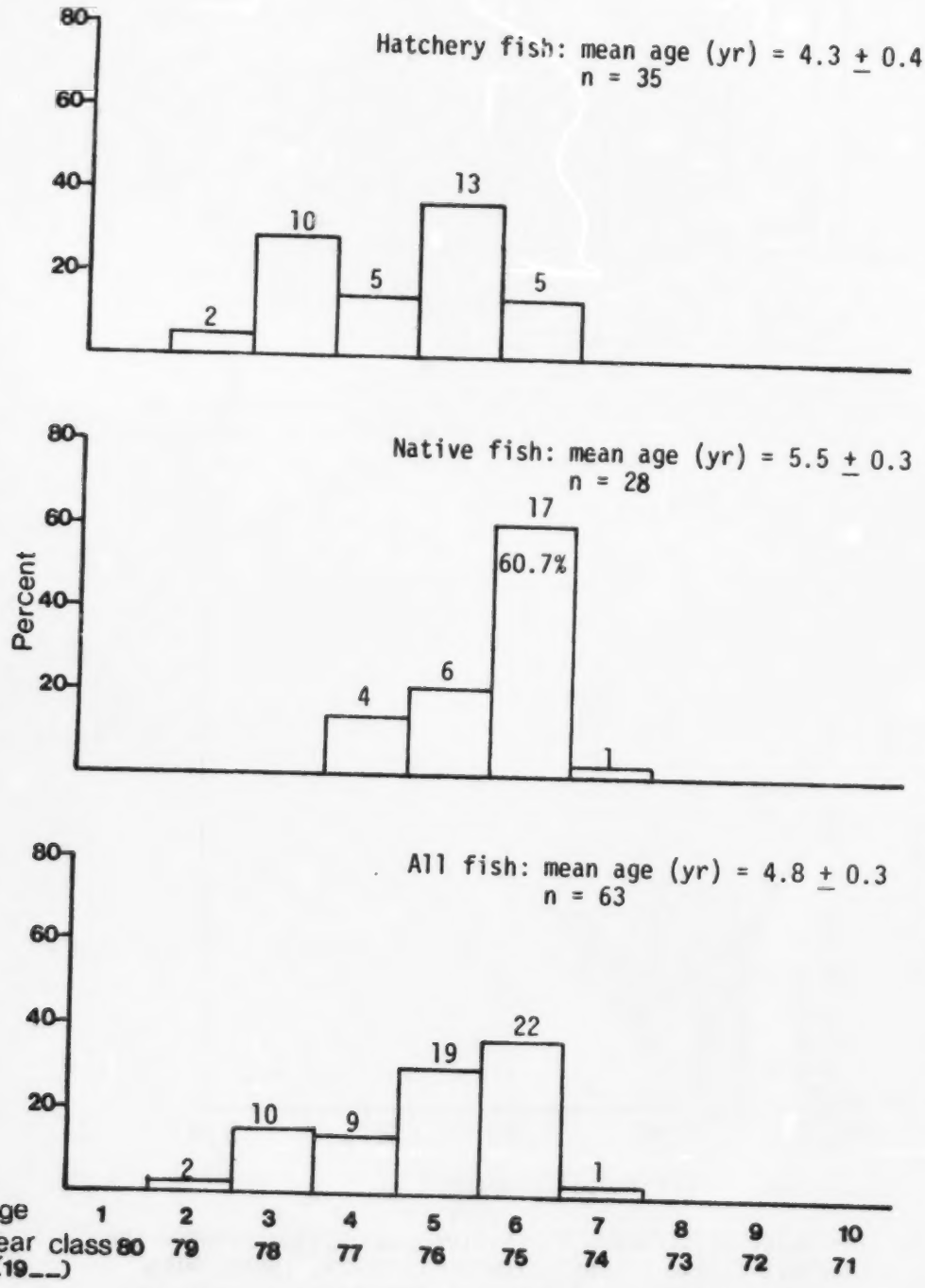


Figure 4.45 Age distributions of lake trout sampled during the winter 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

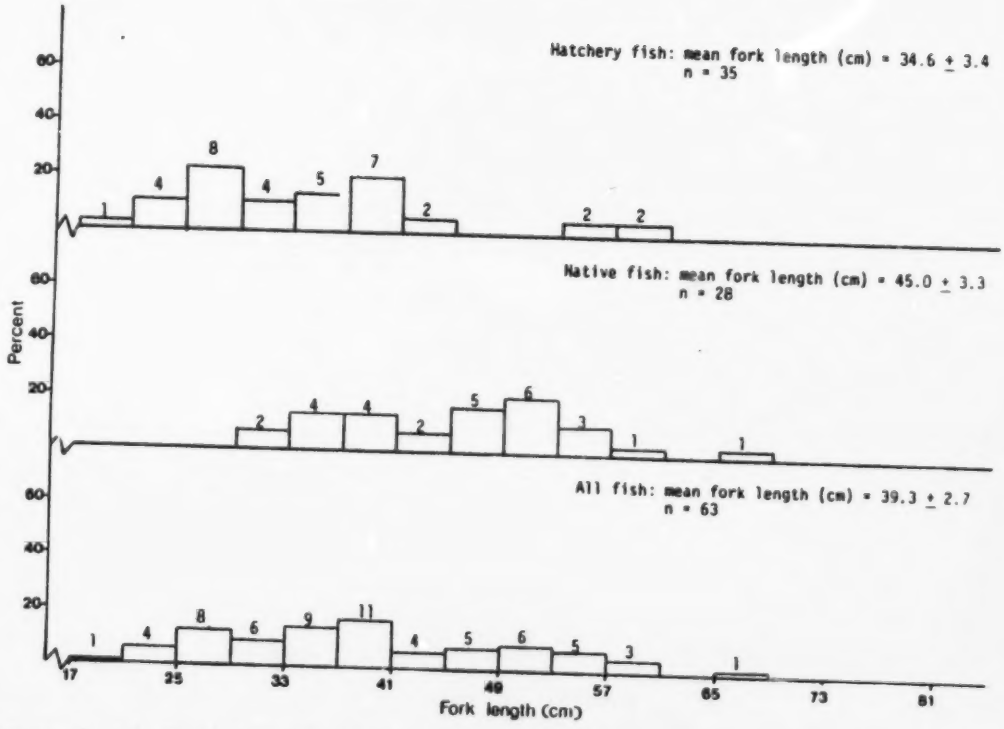


Figure 4.46 Fork length distributions of lake trout sampled during the winter 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

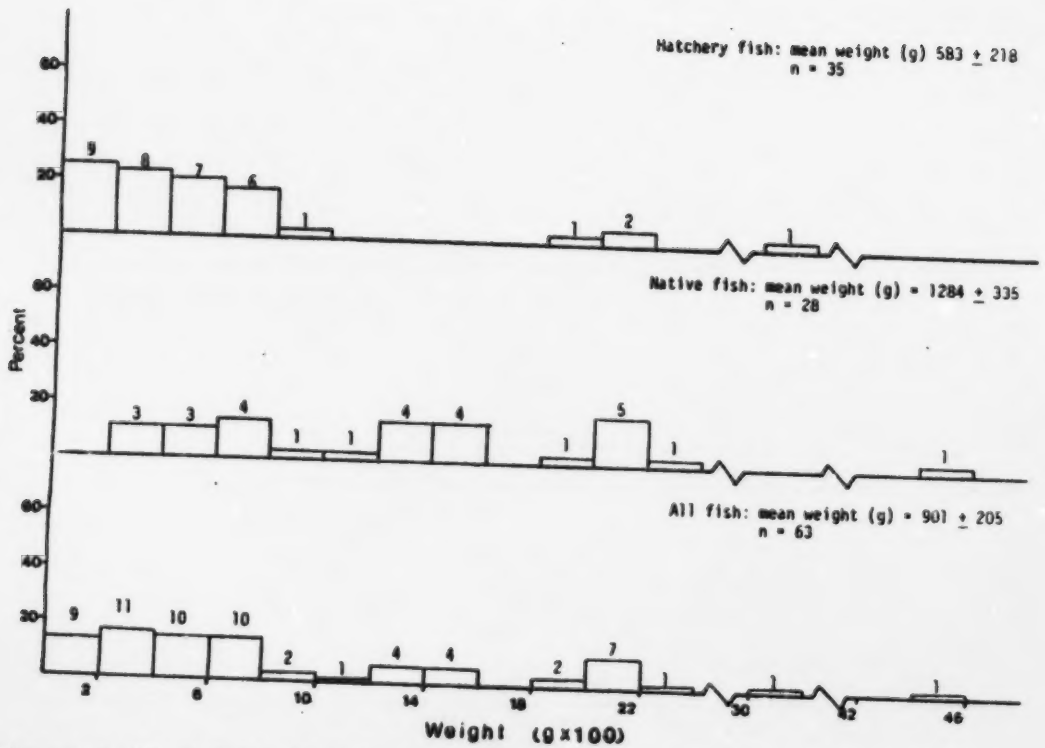

Hatchery fish: mean weight (g) 583 ± 218
n = 35
Native fish: mean weight (g) = 1284 ± 335
n = 28
All fish: mean weight (g) = 901 ± 205
n = 63
Percent
Weight (g x100)

Figure 4.47 Weight distributions of lake trout sampled during the winter 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

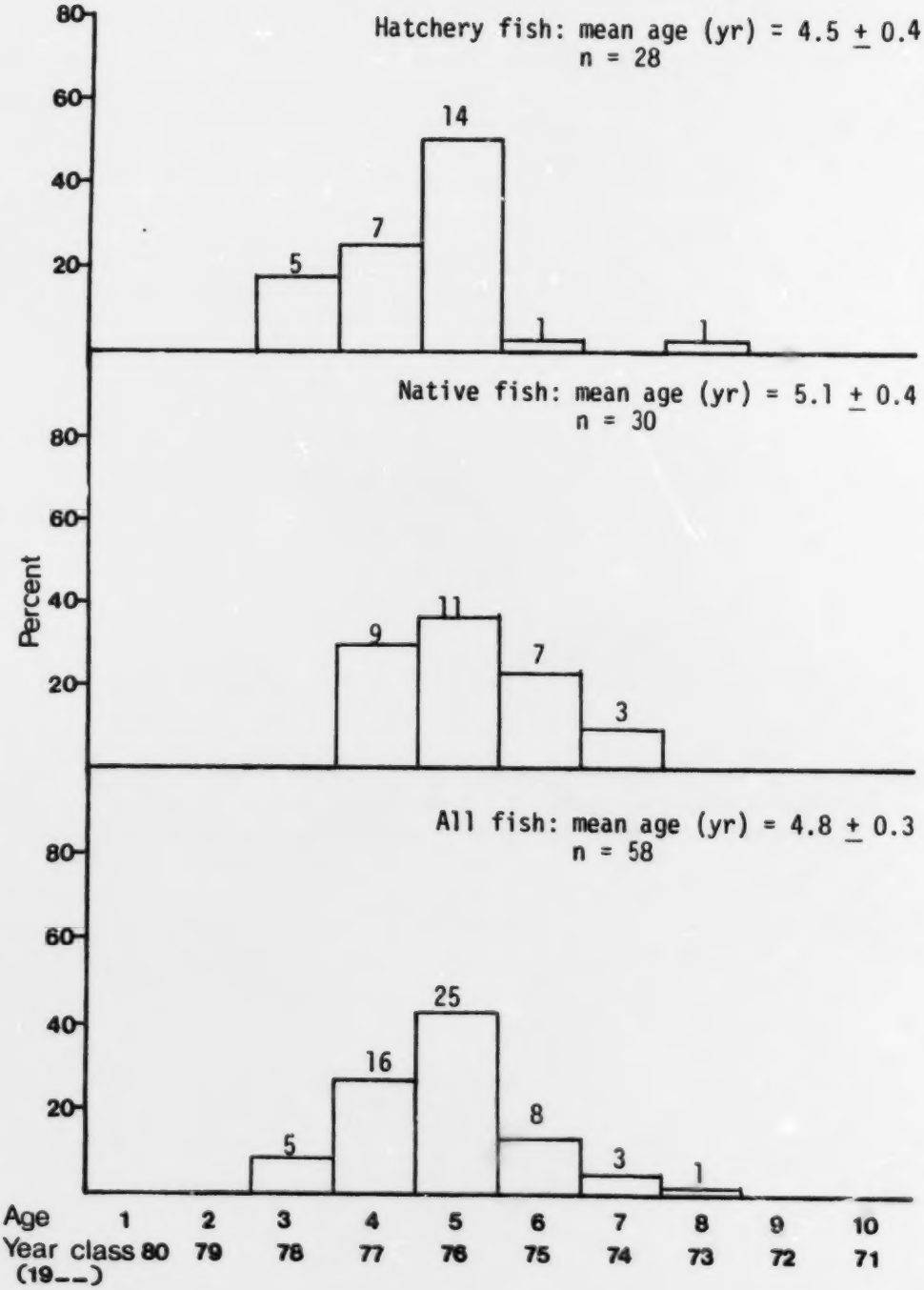


Figure 4.48 Age distribution of lake trout sampled during the summer 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

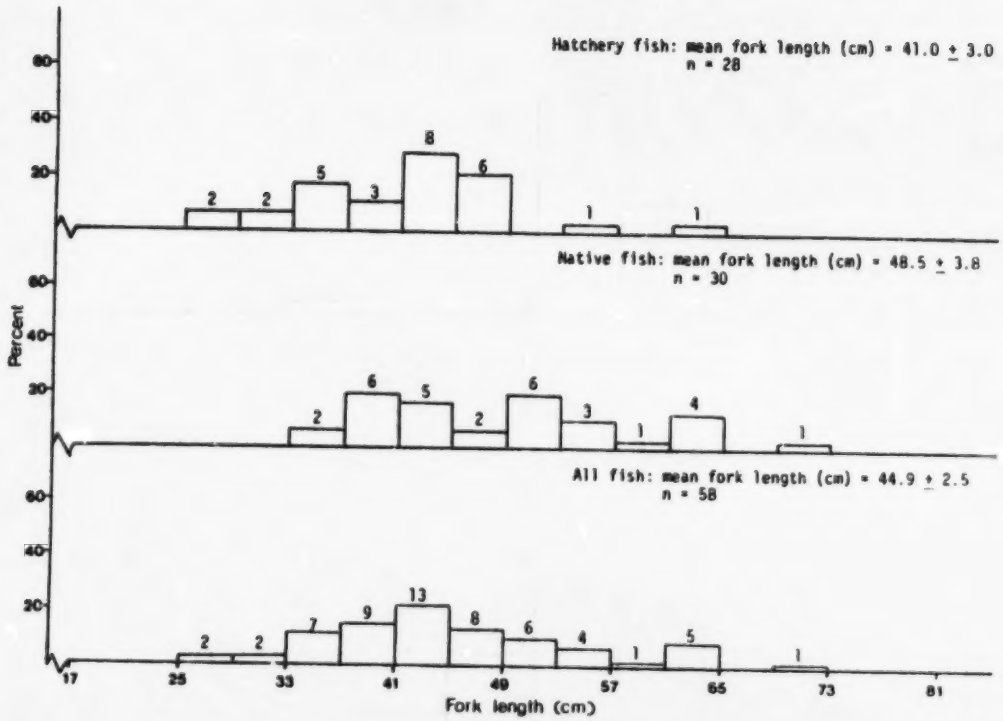


Figure 4.49 Fork length distributions of lake trout sampled during the summer 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

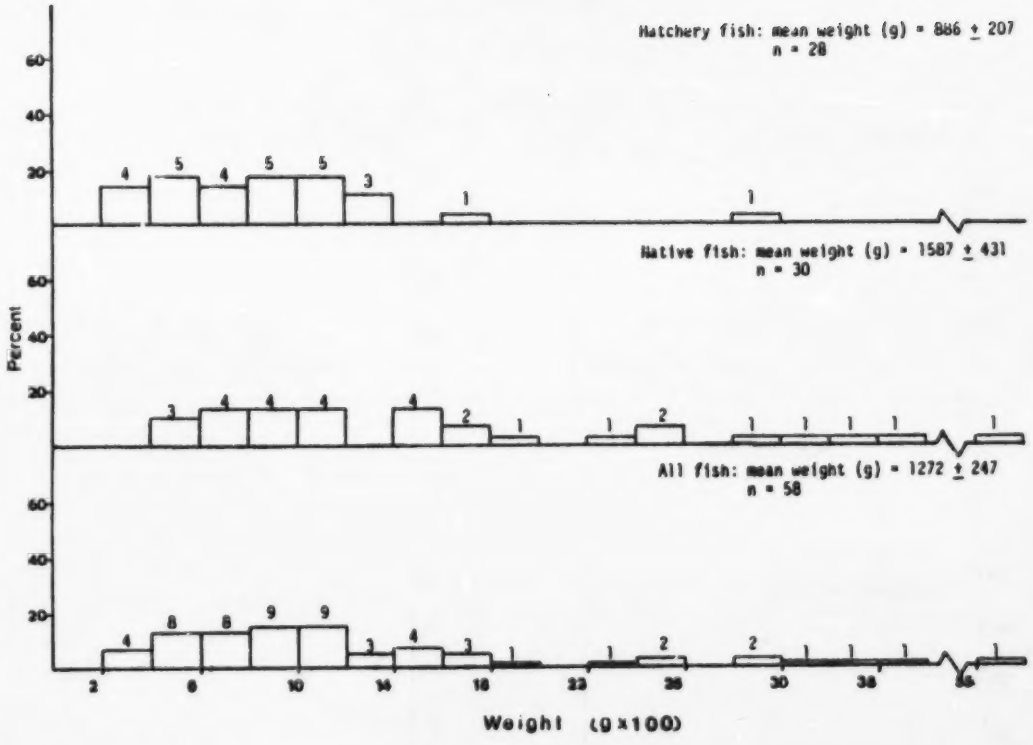

Hatchery fish: mean weight (g) = 886 ± 207
n = 28
Native fish: mean weight (g) = 1587 ± 431
n = 30
All fish: mean weight (g) = 1272 ± 247
n = 58
Percent
Weight (g x100)

Figure 4.50 Weight distributions of lake trout sampled during the summer 1981 sport fishery on Charleston Lake. Numbers over each bar indicate actual count frequencies.

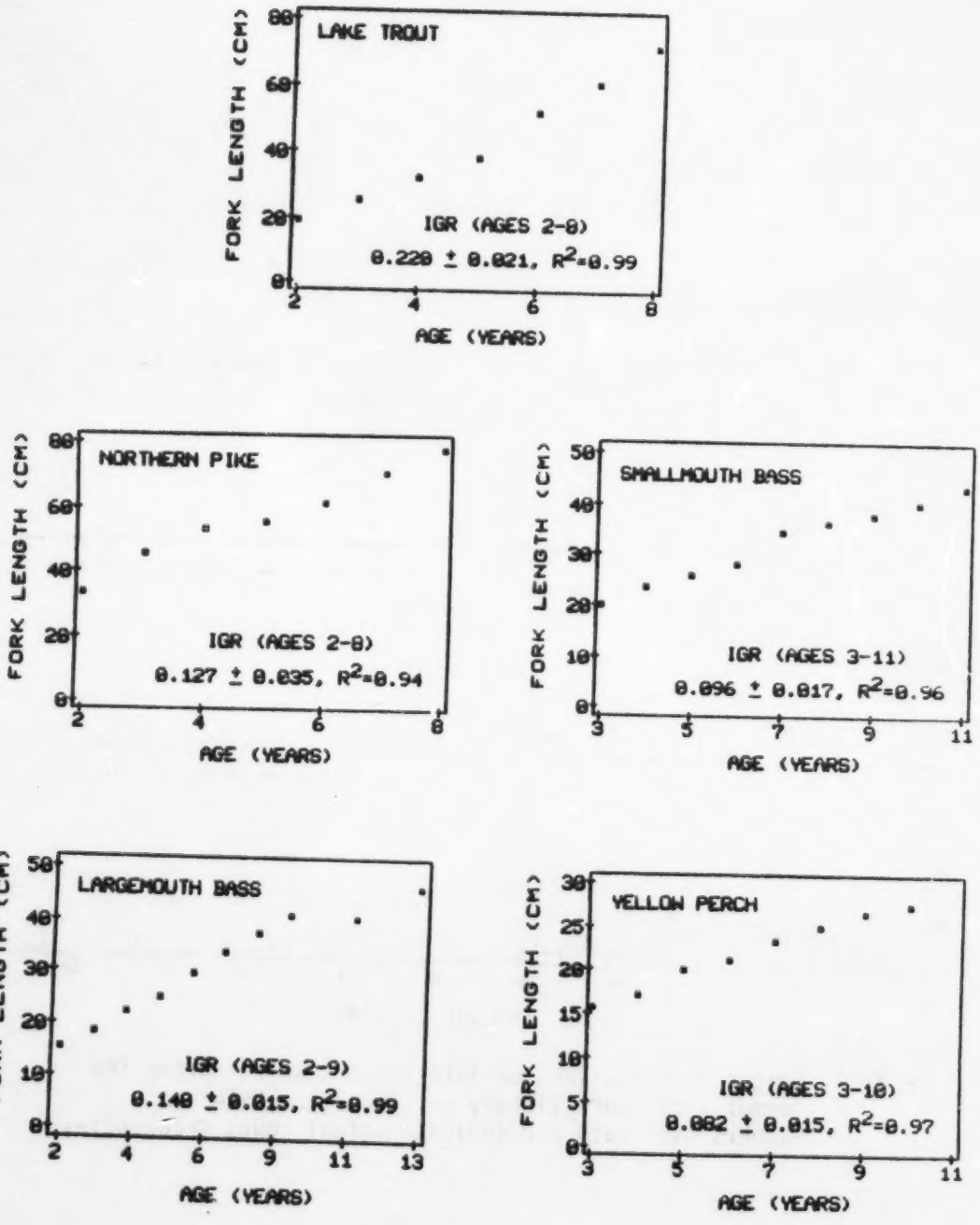


Figure 4.51 Absolute growth rate of lake trout, northern pike, smallmouth bass, largemouth bass, and yellow perch sampled at Charleston Lake, 1981. Lake trout were sampled during the winter 1981 creel census. The other target species were sampled during the index trapnetting, May 20-29, 1981. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

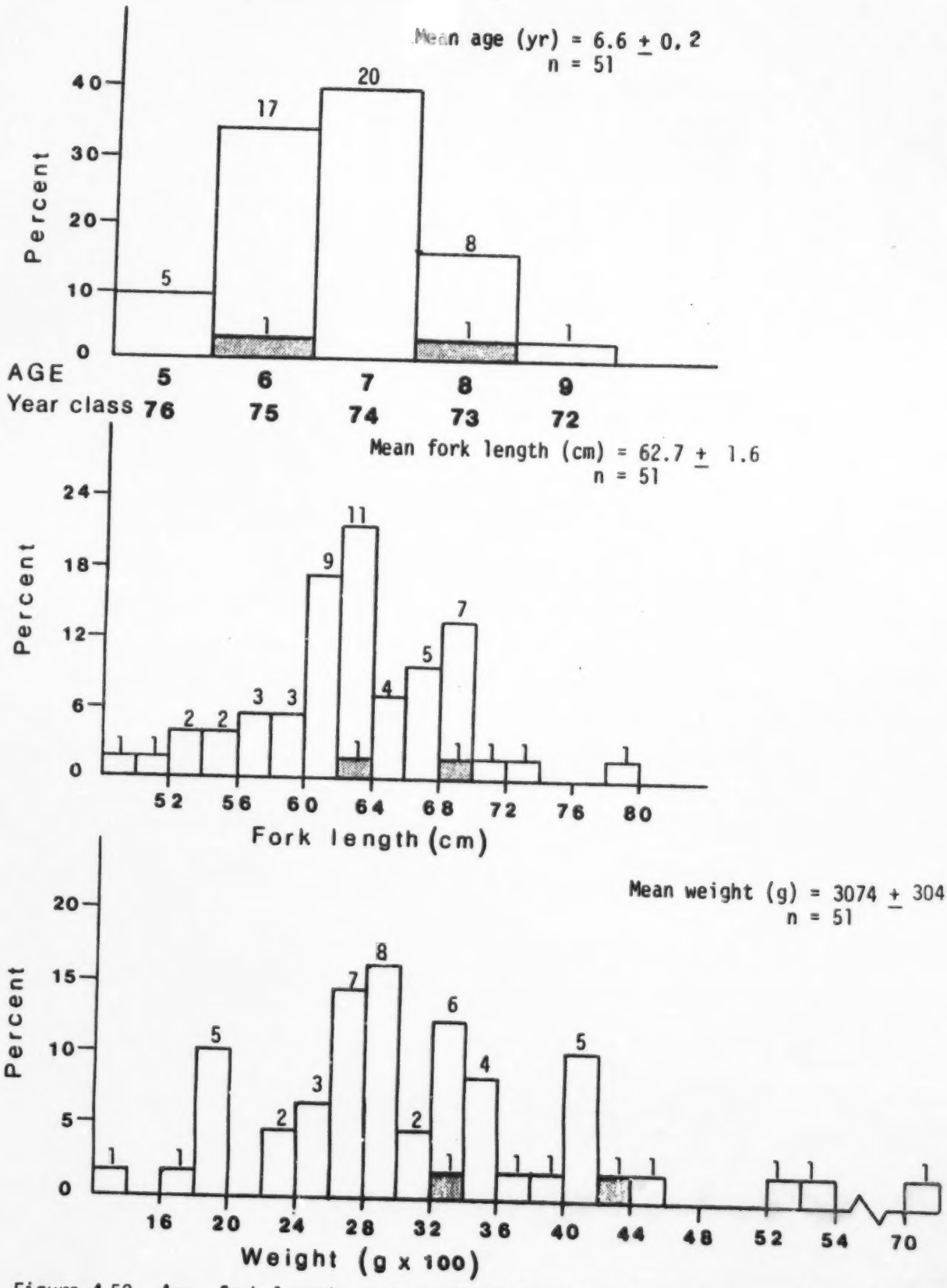
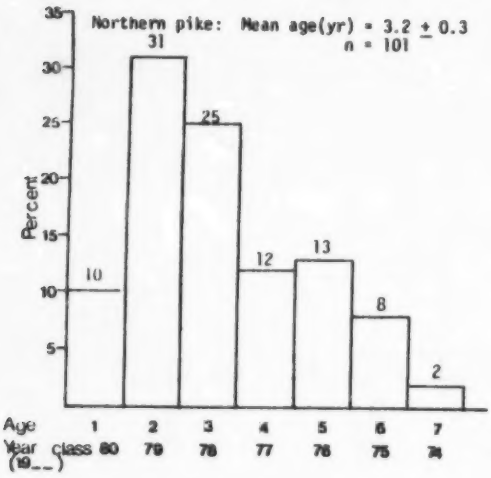
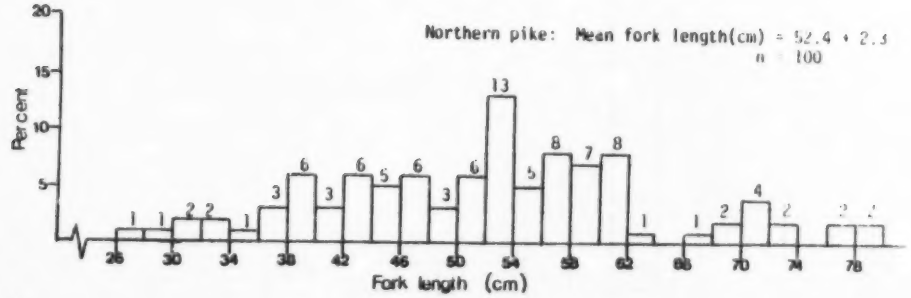

Mean age (yr) = 6.6 ± 0.2
n = 51
Percent
AGE
Year class 76 75 74 73 72
Mean fork length (cm) = 62.7 ± 1.6
n = 51
Fork length (cm)
Mean weight (g) = 3074 ± 304
n = 51
Weight (g x 100)

Figure 4.52 Age, fork length, and weight distributions of lake trout sampled during spawning assessment on Charleston Lake, October 13-28, 1981. Numbers over each bar indicate actual count frequencies. ▒ indicates fish of hatchery origin.





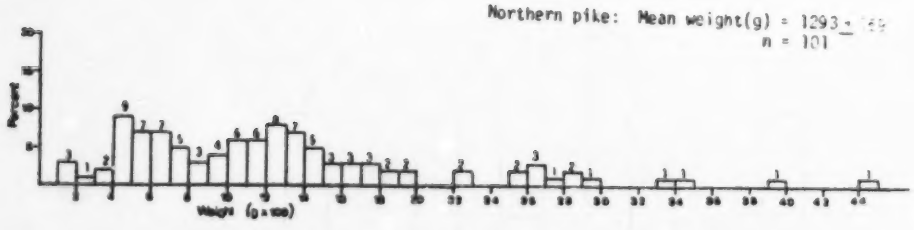


Figure 4.53 Age, fork length, and weight distributions of northern pike captured in trapnets on Charleston Lake, May 20-29, 1981. Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

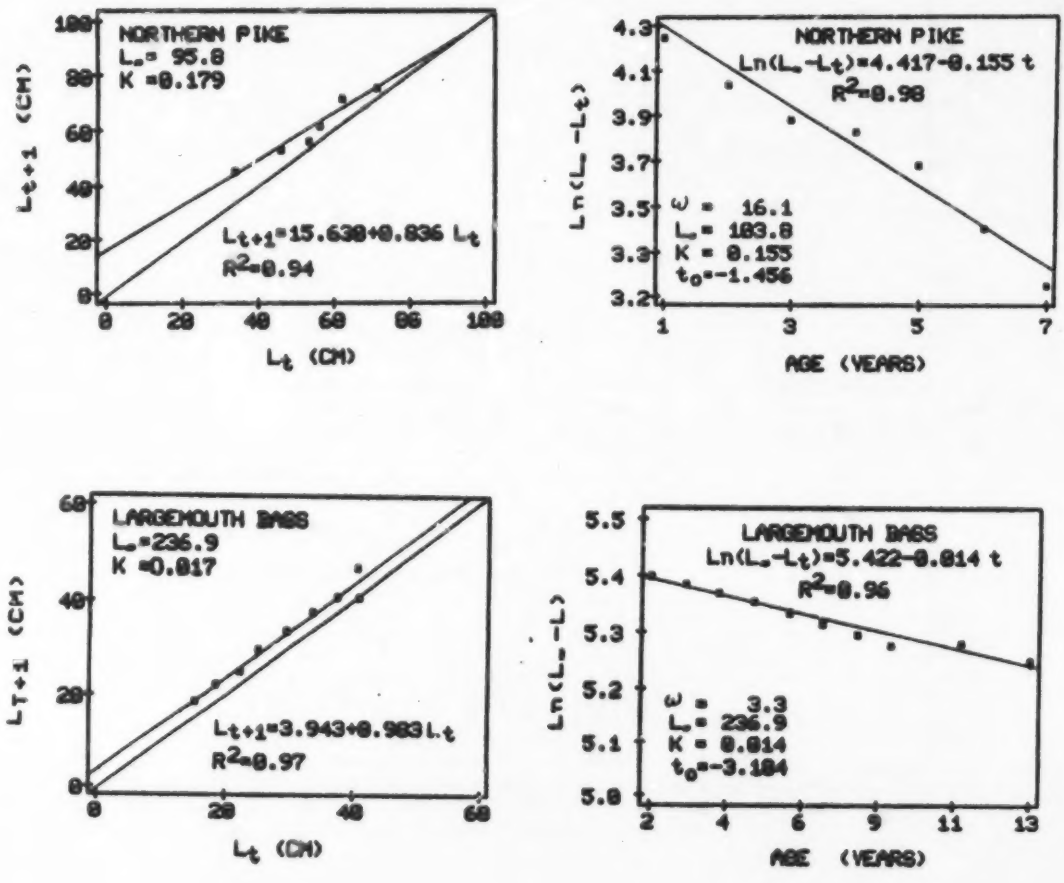


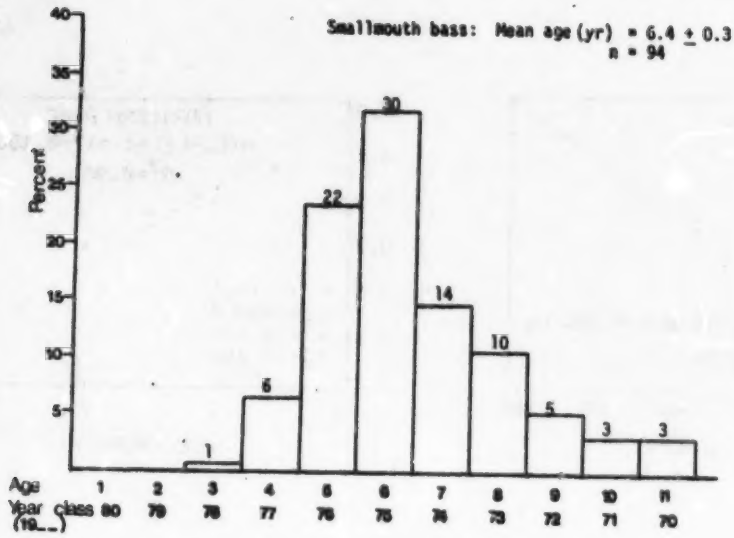
Figure 4.54 Walford, L_{t+1} against L_t, and von Bertalanffy, $Ln(L_\infty - L_t)$ against age, plots, based on mean lengths (cm) at age for northern pike, and largemouth bass captured in Charleston Lake, May 20-29, 1981.

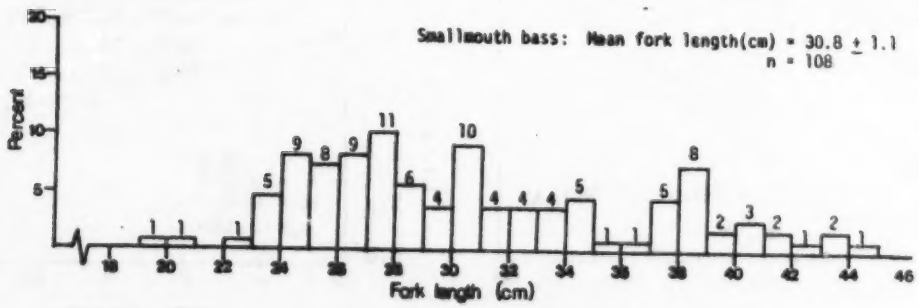
L_∞ is the ultimate length (cm) of the population.

K is the growth coefficient.

t_0 is the time when length is theoretically zero.

$\omega = K \times L_\infty$ (Galluci and Quinn 1979, based on linear regression).





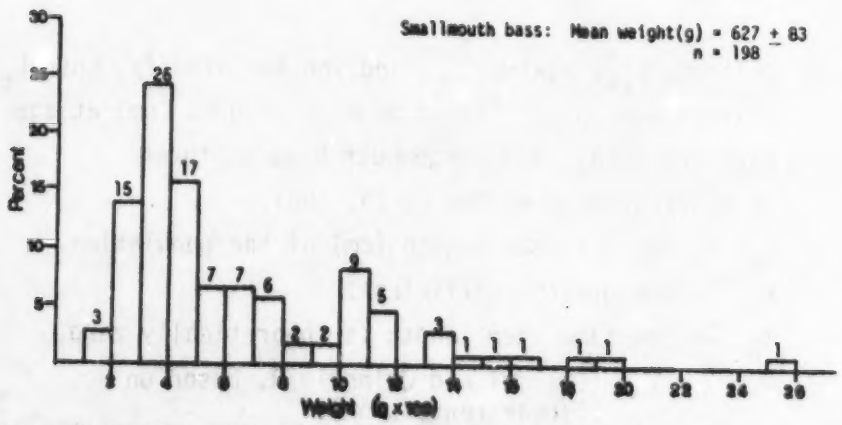
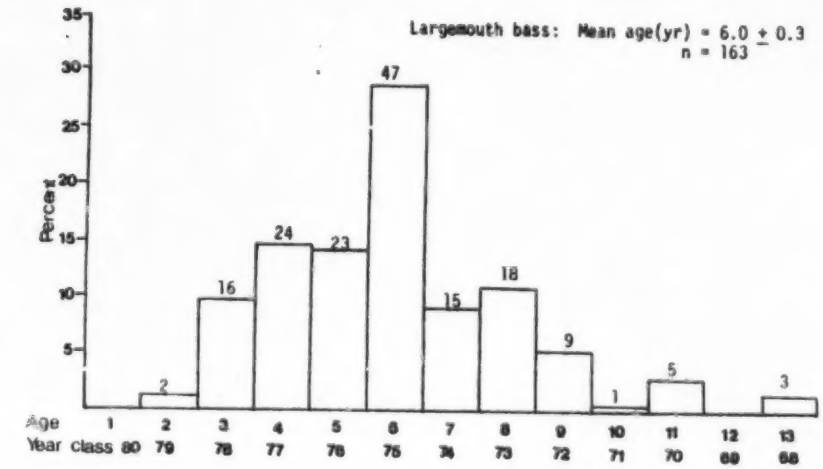
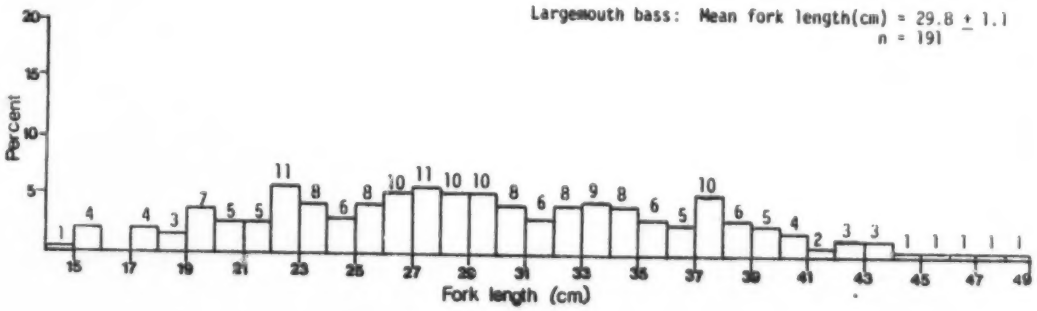


Figure 4.55 Age, fork length, and weight distributions of smallmouth bass captured in trapnets on Charleston Lake, May 20-29, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.





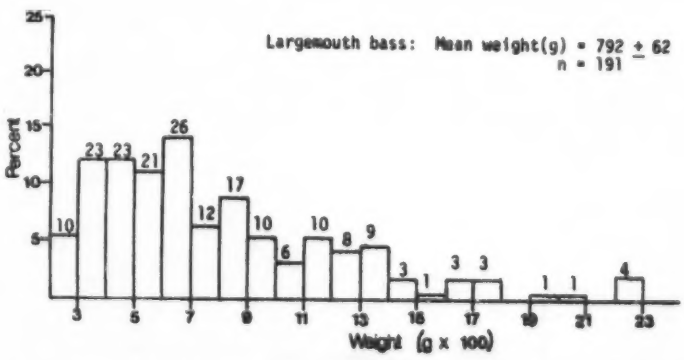
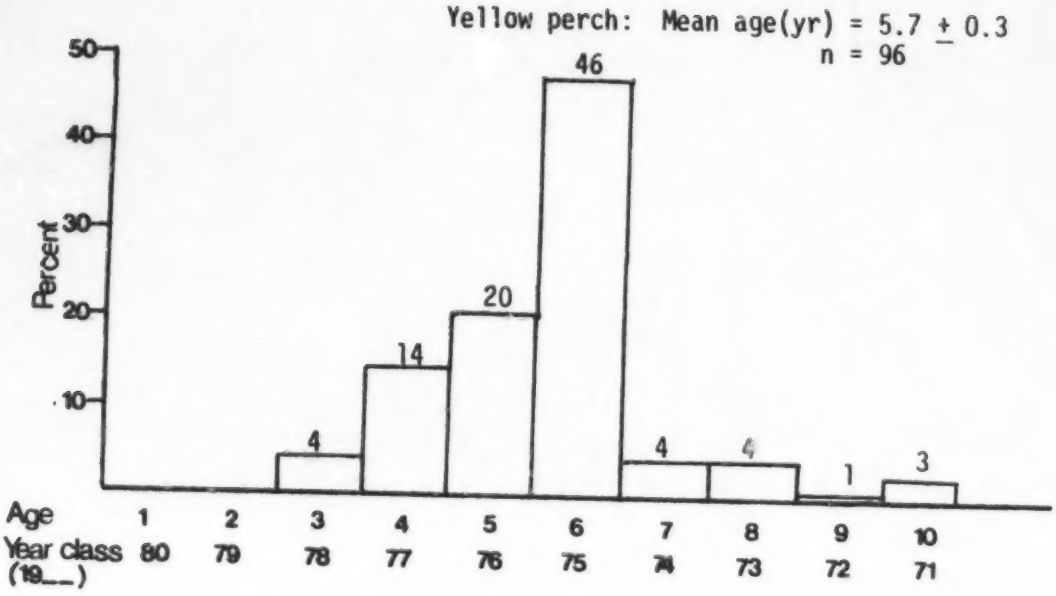
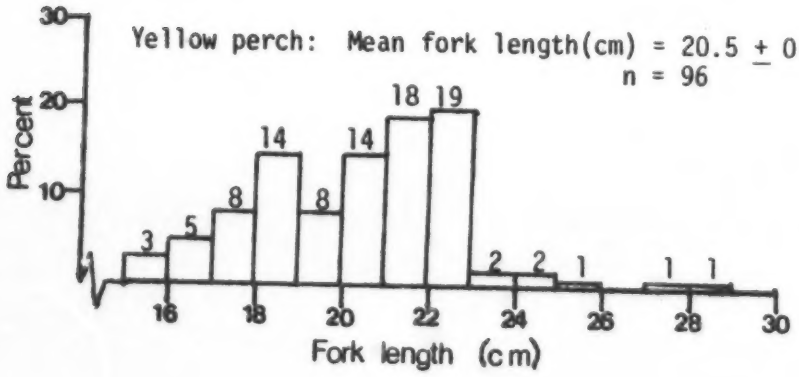


Figure 4.56 Age, fork length, and weight distributions of largemouth bass captured in trapnets on Charleston Lake, May 20-29, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.





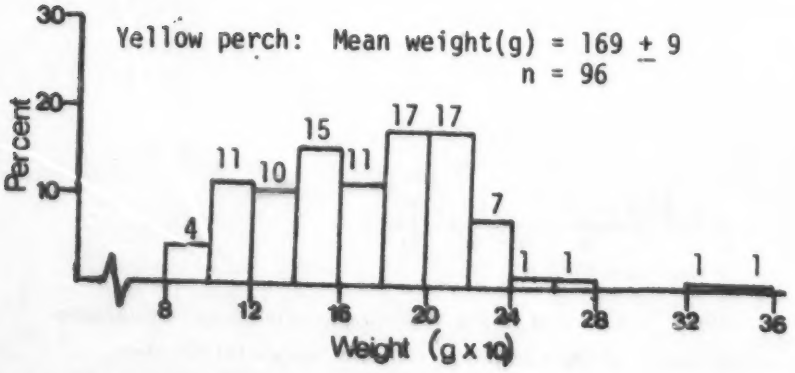


Figure 4.57 Age, fork length, and weight distributions of yellow perch captured in trapnets on Charleston Lake, May 20-29, 1981. Numbers over each bar indicate actual count frequencies.

4.5 DEVIL LAKE

4.5.1 Community Structure

Species composition and diversity - Bluegill (59.8%) comprised the greatest percentage of the catch, followed by pumpkinseed (13.1%), rock bass (6.7%), largemouth bass (5.7%), brown bullhead (4.2%), black crappie (3.9%), smallmouth bass (3.3%), and yellow perch (1.2%). Northern pike, white sucker, golden shiner, and yellow bullhead each made up <1% of the catch. Most of the fish were caught at trapnet sites 1, 4, and 7 (Table 4.33, Figure 4.58).

The relative abundance of fishes in the littoral zone generally parallels the species composition data presented above. In early June, the littoral zone was dominated by bluegill and pumpkinseed were moderately abundant. Northern pike, white sucker, golden shiner, yellow bullhead, brown bullhead, rock bass, smallmouth bass, largemouth bass, black crappie, and yellow perch were present but relatively uncommon (Table 4.34).

Rock bass, bluegill, lake herring, and lake trout were the most abundant species in the gillnet catch. The ratio of lake herring to lake trout was 1.3:1 (Table 4.34).

The overall diversity index was 2.09 and ranged from 1.73 (Site 4) to 2.54 (Site 6) for individual trapnet locations (Fig. 4.59).

With respect to species composition, site 5 had the lowest percentage similarity, while sites 1, 2, 4, 6, and 7 were very similar (Fig. 4.59).

The dissimilarity of site 5 was the result of its relatively higher proportional abundance of rock bass compared to the other locations (sites 1, 2, 4, 6, and 7) (Fig. 4.60, Table 4.33) and accounted for 59% of the variation among the trapnet sites (Table 4.35).

Most of the remaining variation (21%) among the trapnets was explained by the contrast in the percentage of bluegill, pumpkinseed, and brown bullhead (Table 4.35) caught at sites 1, 2, 4, 6, and 7. Site 7, at one end of the scale had the highest proportion of bluegill but lowest percentage of pumpkinseed and brown bullhead while the opposite relationship was found at site 6 (Fig. 4.60, Table 4.33).

4.5.2 Population Characteristics

Lake trout - Lake trout age, fork length, and weight distributions from the 1981 winter and summer sport fisheries are depicted in Figures 4.61 - 4.66. Mean values with 95% confidence limits are shown below.

	Age (yr)	Total Length (cm)	Fork Length (cm)	Weight (g)
Winter				
hatchery	4.1 ± 0.9	37.4 ± 6.8	34.1 ± 6.8	475 ± 320
native	4.7 ± 0.4	44.7 ± 4.5	40.9 ± 4.3	989 ± 450
all	4.6 ± 0.4	43.3 ± 3.9	39.6 ± 3.7	891 ± 371
Summer				
hatchery	2.5 ± 19.1	28.0 ± 9.5	25.6 ± 8.3	169 ± 83
native	5.8 ± 0.4	52.0 ± 3.9	47.5 ± 3.7	1567 ± 491
all	5.6 ± 0.5	50.1 ± 4.0	46.6 ± 3.8	1509 ± 482

Ages in the winter sport fishery ranged from 3-8 years with the 1976 and 1977 (ages 4 and 5) year classes the most abundant (Fig. 4.61). Ages in the summer fishery ranged from 1-10 years with the 1975 (age 6) year class the most abundant (Fig. 4.64).

Nineteen percent of the lake trout harvested during the winter fishery and 4% of those harvested during the summer fishery were of hatchery origin.

The growth rate of lake trout in Devil Lake is greater than expected for Ontario populations. Fork lengths-at-age were much greater than the standard growth curve for lake trout (MNR 1983). The growth indices for the two most abundant year classes, ages 4 and 5, were 126% and 127%, respectively and the mean growth index for all ages was 130% (Table 4.36). The instantaneous growth rate for lake trout was 0.188 ± 0.045 based on ages 3-8 (Fig. 4.67). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.37).

The total mortality rate for lake trout sampled during the winter creel was 0.63 (ages 4-7), exceeding the the critical level (0.50) for lake trout (MNR 1983). The rate during the summer creel was 0.47 (Table 4.38).

Parasitic evaluations, based on a qualitative analysis of lake trout from creels, gillnets, and spawning assessments, indicate that, externally, Salmincola and internally, tapeworms, commonly affect lake trout living in Devil Lake. Occurences of fin rot, gill and intestinal flukes, and leech parasitism were incidental.

Lake trout in Devil Lake appear to be primarily piscivorous. Stomach contents from 15 lake trout were examined. Seventy-eight percent of the food items were identified as fish products, 43% were sculpin, 21% were herring, and 14% were non-identifiable fish species. Opposum shrimp made up the remaining 21% of the stomach contents. Four stomachs were empty.

Substantial lake trout spawning runs were observed at six of the 11 shoals monitored (Table 4.39). Most spawning occurred along the shoreline in 0.5-1.5 m (an exception is shoal #3c, a submerged offshore shoal approximately 3m deep). The mean age (5.9 ± 0.4 yr), mean fork length (57.7 ± 5.7 cm), and mean weight (3178 ± 582 g) of 36 spawning lake trout were considerably greater than those of lake trout caught in the sport fishery (Fig.4.68). The ratio of male to female lake trout on the shoals

was 4.8:1. None of these spawning lake trout were of hatchery origin.

Northern pike - The mean age of northern pike captured in the trapnets was 3.7 ± 0.3 years, mean fork length was 48.4 ± 2.6 cm, and mean weight was 930 ± 195 g. Ages ranged from 2-7 years with the 1978 (age 3) year class the most abundant (Fig. 4.69).

The growth rate of Devil Lake northern pike is similar to that expected for Ontario populations. Fork lengths-at-age were equivalent to the standard growth curve (MNR 1983) and the mean growth index for all ages was 103% (Table 4.36). The instantaneous growth rate was 0.167 ± 0.137 based on ages 3-6 (Fig. 4.67). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.37).

The total mortality rate of the northern pike sampled in the trapnets was 0.64 based on ages 3-6 (Table 4.38). This rate is similar to the critical level (0.65) for northern pike (MNR 1983).

Table 4.40 summarizes the percent occurrence of external parasites for target species sampled during trapnetting. Blackspot was the most common external parasite observed on northern pike.

Smallmouth bass - The mean age of smallmouth bass caught in the trapnets was 4.5 ± 0.2 years, mean fork length was 24.6 ± 0.9 cm, and mean weight was 280 ± 40 g. Ages ranged from 3-12 with the 1977 (age 4) year class the most abundant (Fig. 4.70).

The instantaneous growth rate was 0.116 ± 0.017 based on ages 3-11 (Fig. 4.67).

The growth parameters calculated from the Walford (L_∞= 49.9, k=0.155) and von Bertalanffy (L_∞=49.9, k=0.156, t_0=-0.009, w=7.8) analyses (Table 4.37, Fig. 4.71) appear to be realistic estimates. L_∞ approximates the maximum mean total length-at-age (45.7 cm) reported from Baie du Dore, Lake Huron (Scott and Crossman 1973).

The total mortality rate for smallmouth bass caught in the trapnets was 0.51, based on ages 4-9 (Table 4.38). This rate is slightly exceeds the critical level (0.50) for smallmouth bass (MNR 1983). Ninety-four percent of the sport fishery catch was in the age 4-9 interval (MacLean and Schlesinger 1982). Therefore, the mortality rate determined from trapnet data is representative of the population's response to 1981 effort levels.

Blackspot was the most common external parasite observed on smallmouth bass during trapnetting (Table 4.40).

Largemouth bass - The mean age of the largemouth bass caught in the trapnets was 4.9 ± 0.2 years, mean fork length was 28.4 ± 0.7 cm, and mean weight was 434 ± 41 g. Ages ranged from 2-12 with the 1977 (age 4) year class the most abundant (Fig. 4.72).

The instantaneous growth rate was 0.107 ± 0.024 based on ages 2-11 (Fig. 4.67).

A growth rate similar to or slightly greater than expected for Ontario largemouth bass populations is indicated by the

parameters estimated from the Walford (L_∞=56.9, K=0.134) and von Bertalanffy (L_∞=60.9, K=0.116, t_0=-0.609, Φ'=7.1) models (Table 4.37, Fig. 4.71). The estimate of L_∞ is in close agreement with the average maximum population length (53.3) reported for Ontario (MacKay 1963).

The total mortality rate of the largemouth bass sampled on Devil Lake was 0.38 based on ages 4-12 (Table 4.38). All of the sport fishery catch was in the 4-10 age interval (MacLean and Schlesinger 1982). Therefore, the mortality rate determined from trapnet data is representative of the population's response to 1981 effort levels.

Blackspot was the most common external parasite observed on largemouth bass during trapnetting (Table 4.40).

Yellow perch - The mean age of yellow perch captured in the trapnets was 4.5 ± 0.3 years, mean fork length was 18.7 ± 0.9 cm, and mean weight was 86 ± 18 g. Ages ranged from 3-8 years with the 1977 (age 4) year class the most abundant (Fig. 4.73).

The instantaneous growth rate was 0.142 ± 0.043 based on ages 3-7 (Fig. 4.67).

The total mortality rate for yellow perch sampled on Devil Lake was 0.66 based on ages 4-8 (Table 4.38).

The incidence of external parasites on yellow perch was low (Table 4.40).

Table 4.33 Species composition and total catch at Devil Lake during June 3-12, 1981 index trapnetting.
Blank spaces denote no catch.

Species	Trapnet Percent Composition							Total Catch
	TN1	TN2	TN4	TN5	TN6	TN7	All Sites	
Northern pike	1.7	0.4	0.2	0.2	1.7	1.1	0.9	49
White sucker	1.3	0.1	0.1	0.2			0.4	21
Golden shiner						0.1	<0.1	2
Yellow bullhead	2.3	0.3	0.5	0.2	1.7	0.1	0.9	47
Brown bullhead	6.7	5.0	2.7	0.6	6.1	3.7	4.2	228
Rock bass	6.0	4.3	5.4	21.6	6.6	4.6	6.7	366
Pumpkinseed	11.8	11.9	20.4	16.9	17.7	5.8	13.1	715
Bluegill	51.2	65.5	63.3	50.6	44.2	67.1	59.8	3268
Smallmouth bass	3.4	4.7	2.6	5.9	2.8	2.4	3.3	182
Largemouth bass	8.9	6.7	2.8	3.3	4.4	6.1	5.7	313
Black crappie	4.7	0.6	1.1	0.2	3.3	8.7	3.9	212
Yellow perch	1.9	0.4	0.8	0.2	11.6	0.2	1.2	65
Total catch	1368	675	1350	490	181	1404		5468
Percent catch	25.0	12.3	24.7	9.0	3.3	25.7	100.0	

Table 4.34 CUE for fishes caught at Devil Lake during 1981 by trapnet and gillnet.
Blank spaces denote no catch.

Species	Observed CUE by Gear type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Lake herring		19
Lake trout		15
Northern pike	0.9	1
White sucker	0.4	1
Golden shiner	<0.1	
Yellow bullhead	0.9	
Brown bullhead	4.2	
Rock bass	6.8	21
Pumpkinseed	13.2	3
Bluegill	60.5	20
Smallmouth bass	3.4	3
Largemouth bass	5.8	
Black crappie	3.9	
Yellow perch	1.2	

[1] total number of lifts = 54

[2] total number of lifts = 1

Table 4.35 First two principal components for the six most abundant species caught in trapnets on Devil Lake, June 3-12, 1981.

Species	Principal Component	
	1	2
Brown bullhead	0.4	0.5
Rock bass	-0.7	-0.3
Pumpkinseed	-0.4	0.6
Bluegill	0.3	-0.5
Smallmouth bass	-0.2	-0.1
Largemouth bass	0.3	-0.0
Percent variance	58.8	21.3
Cummulative variance	58.8	80.1

Table 4.36 Mean fork length-at-age (cm), 95% confidence limits and growth indices[1] for fishes captured in Devil Lake, 1981. Values in parentheses are sample sizes.

Species		Age											Mean Growth Index
		II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Lake trout	Mean		28.5+8.6	35.1+2.0	41.6+3.9	45.7+16.4	67.2+9.2	70.6+7.2					
	GI		128	126	127	116	147	138					130
			(4)	(15)	(12)	(3)	(4)	(5)					
Northern pike	Mean	44.0+10.0	43.2+2.2	52.4+5.5	53.2+6.7	75.0+NA	61.6+71.7						
	GI	119	93	99	92	120	92						103
		(4)	(23)	(13)	(8)	(1)	(2)						
Smallmouth bass	Mean		18.9+0.5	22.8+0.5	27.9+1.3	29.5+1.4	33.4+NA	35.7+3.6	40.7+NA		50.2+NA	49.6+NA	
			(36)	(40)	(12)	(23)	(1)	(7)	(1)		(1)	(1)	
Largemouth bass	Mean	16.0+1.5	21.3+0.5	25.8+0.5	29.2+1.4	31.7+0.7	35.7+1.6	37.6+1.6	39.5+1.4	43.7+2.9	46.4+5.1	46.1+24.2	
		(6)	(44)	(44)	(11)	(26)	(11)	(15)	(4)	(3)	(3)	(2)	
Yellow perch	Mean		15.8+1.1	16.8+0.8	19.0+2.2	23.0+2.2	27.5+24.3						
			(28)	(28)	(13)	(9)	(2)						

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for lake trout and northern pike (MNR 1983).

Table 4.37 Walford and Von Bertalanffy growth parameters for target species caught in Devil Lake, 1981. Blank spaces indicate data which did not fit the Von Bertalanffy model.

Species	Ages	Walford			Von Bertalanffy				
		L_{∞} (cm)	K	R^2	L_{∞} (cm)	K	t_o	ω	R^2
Lake trout	3 - 8	232.6	0.046	0.78					
Northern pike	2 - 7	59.6	0.871	0.20					
Smallmouth bass	3 - 8	49.9	0.155	0.95	49.9	0.156	-0.009	7.8	0.99
Largemouth bass	2 - 12	56.9	0.134	0.98	60.9	0.116	-0.609	7.1	0.99

[1] $\omega = K \times L_{\infty}$ (Gallucci and Quinn 1979, based on a linear regression of $Ln(L_{\infty} - L_t)$ against age.

Table 4.38 Total mortality rate for target species captured on Devil Lake, 1981. Lake trout estimates are from winter (w) and summer (s) creel censuses, other species from trapnet data.

Species	Mortality Rate	Confidence Interval	Ages
Lake trout (w)	0.63	0.00 - 0.87	4 - 7
(s)	0.47	0.11 - 0.68	6 - 10
Northern pike	0.64	0.09 - 0.87	3 - 6
Smallmouth bass	0.51	0.00 - 0.78	4 - 9
Largemouth bass	0.38	0.30 - 0.46	4 - 12
Yellow perch	0.66	0.00 - 0.89	4 - 7

Table 4.39 The number of lake trout observed during spawning investigations at 12 shoals on Devil Lake, 13 October - 29 October, 1981.
Blank spaces denote missing data due to weather or logistical constraints.

Date	Shoal												
	1	2	3a	3b	3c	4	5	6	7	8	9	10	11	12
October 13	30	0	3	0	15	0	0	0	0	0	0	0	1	0
October 17	65	0	13	17	0							0	15	19
October 22	50	0	15	0	2							0	30	0
October 25	38	1	1	3	2							0	4	0
October 29	2/1	0	0	0	0							0	1	0

#/# denotes 2 observations on same night.

Table 4.40 The percent occurrence of visible external parasites for target species sampled during trapnetting in Devil Lake, June 3-12, 1981.
Blank spaces denote that no parasite were observed.

Species	No.	Parasite		
		Blackspot	Red sore	Yellow grub
Northern pike	51	71	4	
Smallmouth bass	137	58		1
Largemouth bass	205	43		3
Yellow perch	58	17		19

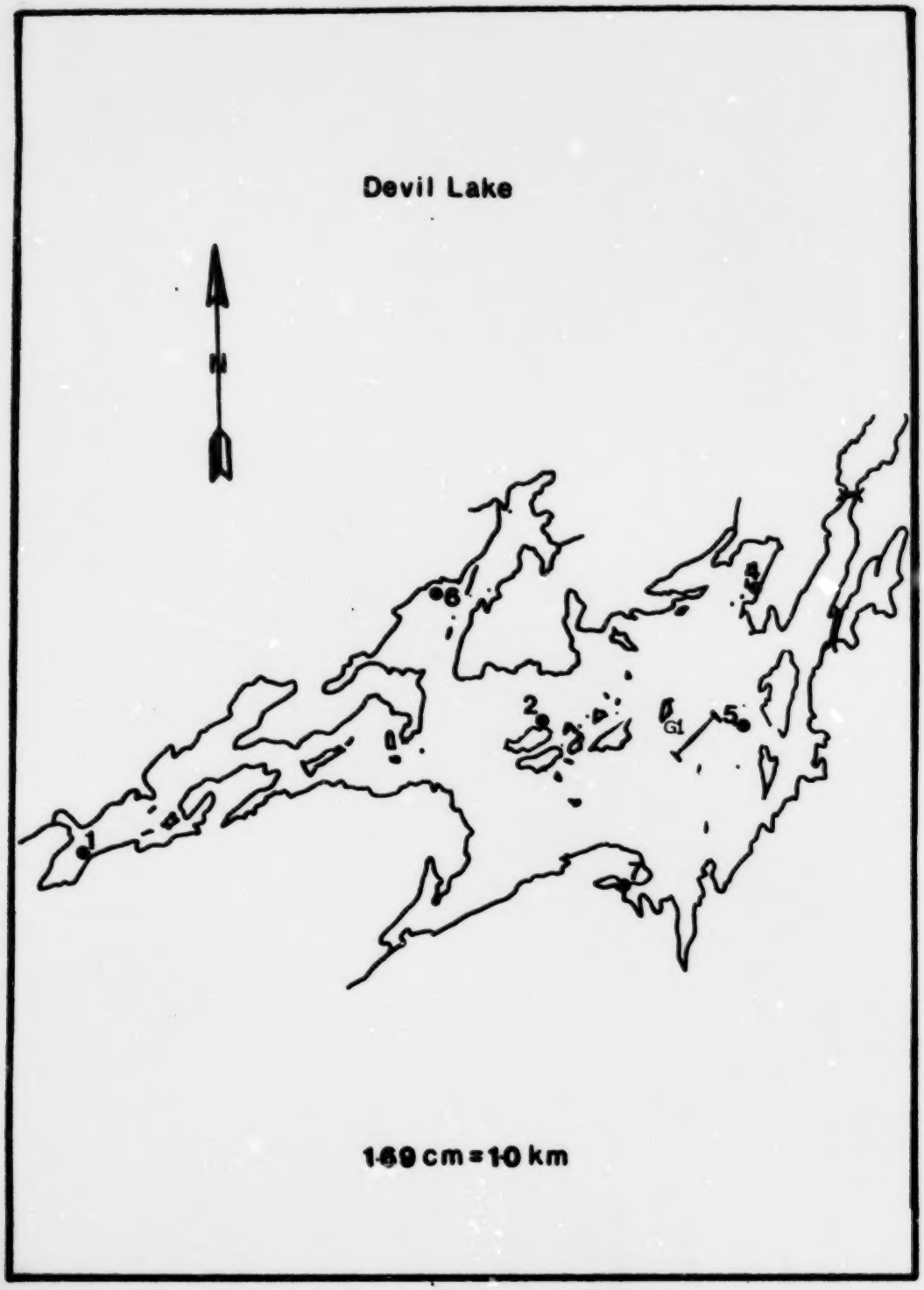


Figure 4.58 Index netting gear locations on Devil Lake, 1981.

● = trapnet location.
⟵⟶ = gillnet location.

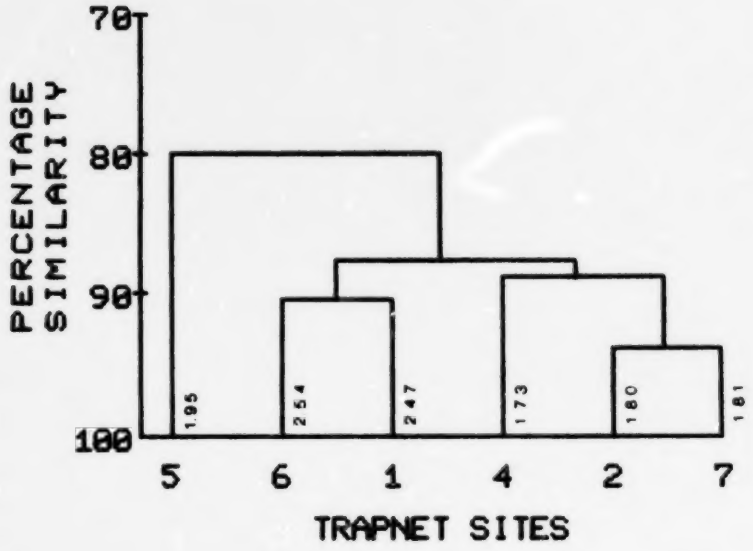


Fig. 4.59 The percentage similarity between the trapnet sites on Devil Lake, June 3-12, 1981. The number next to each cluster is the diversity index for the respective sites.

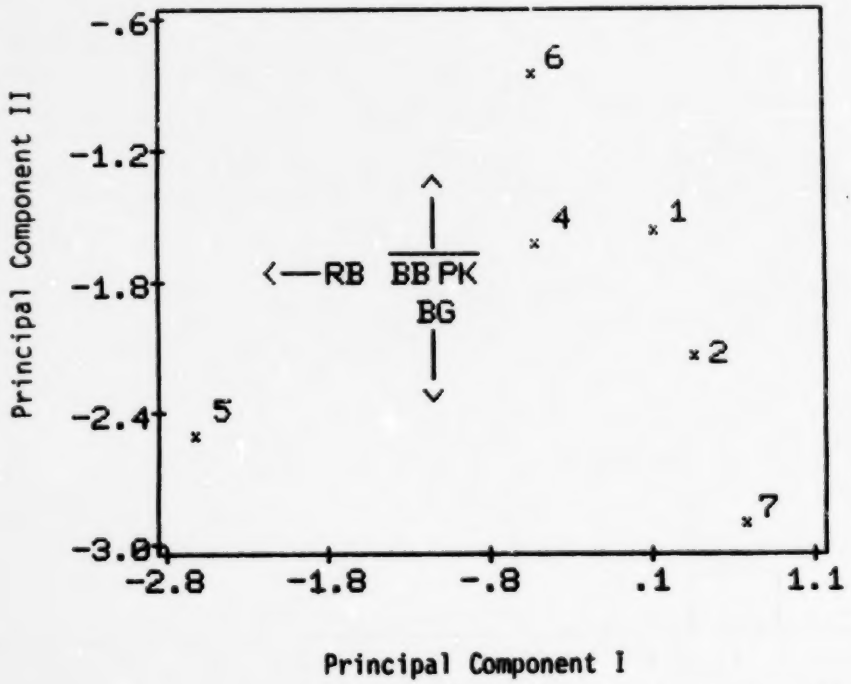


Figure 4.60 The major differences in species composition between the Devil Lake trapnet sites, June 3-12, 1981. With respect to each axis (principal component), the arrows indicate the direction of increasing proportional abundance of the designated species.
RB, rock bass; BG, bluegill; PK, pumpkinseed; BB, brown bullhead.

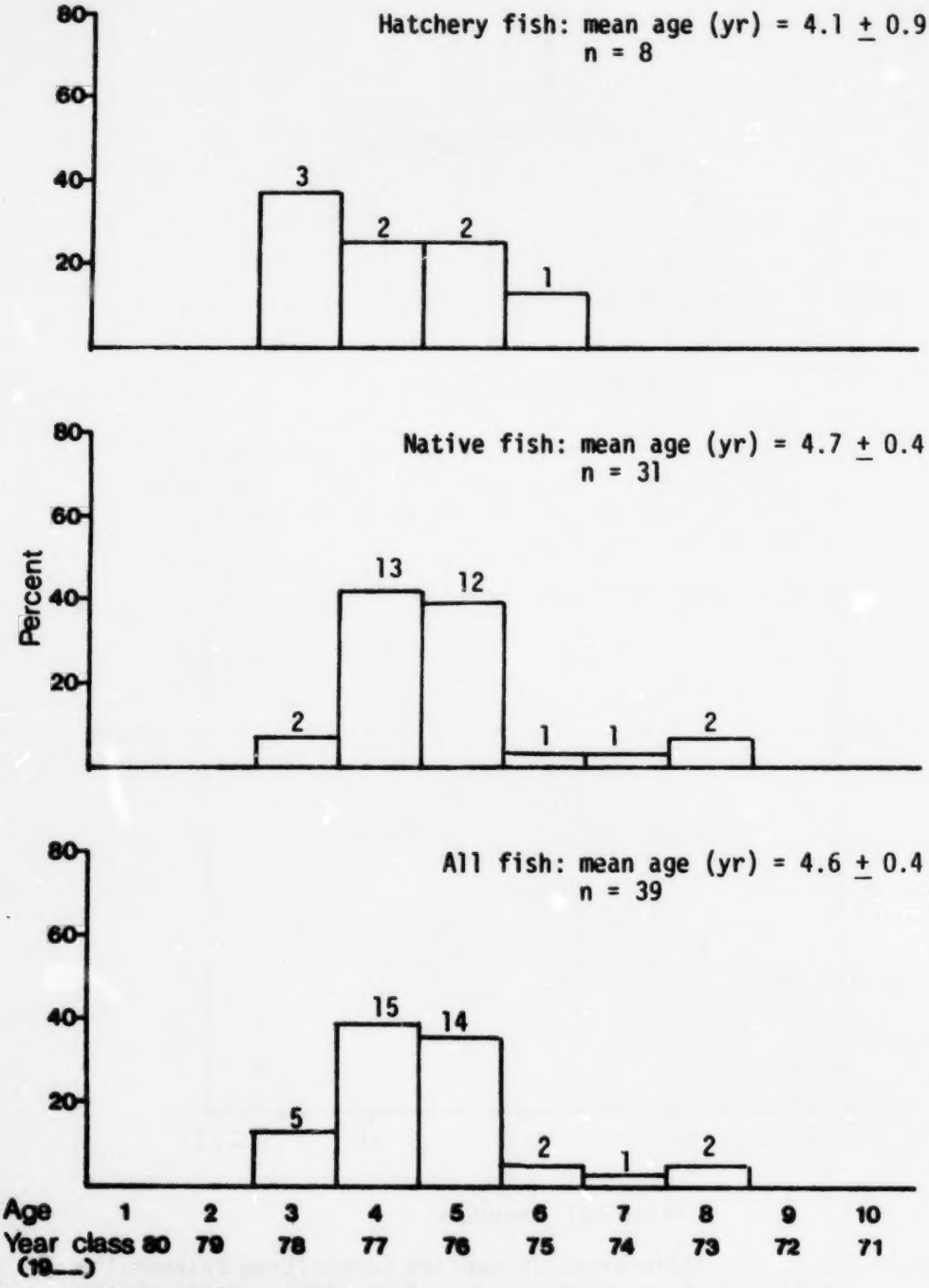


Figure 4.61 Age distributions of lake trout sampled during the winter 1981 sport fishery on Devil Lake. Numbers over each bar indicate actual count frequencies.

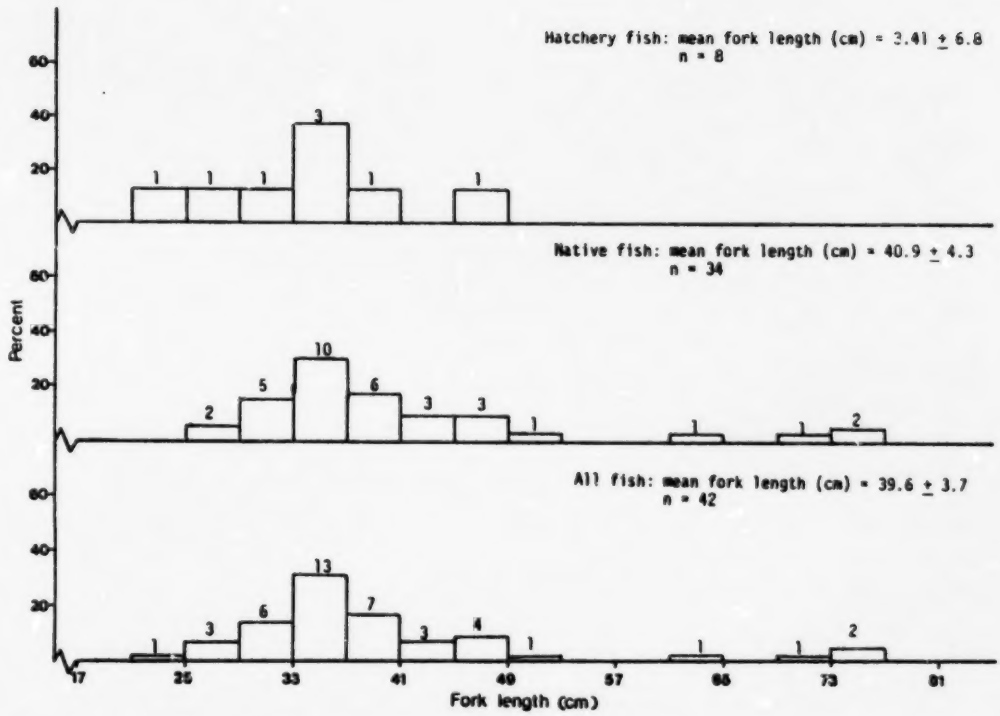


Figure 4.62 Fork length distributions of lake trout sampled during the winter 1981 sport fishery on Devil Lake. Numbers over each bar indicate actual count frequencies.

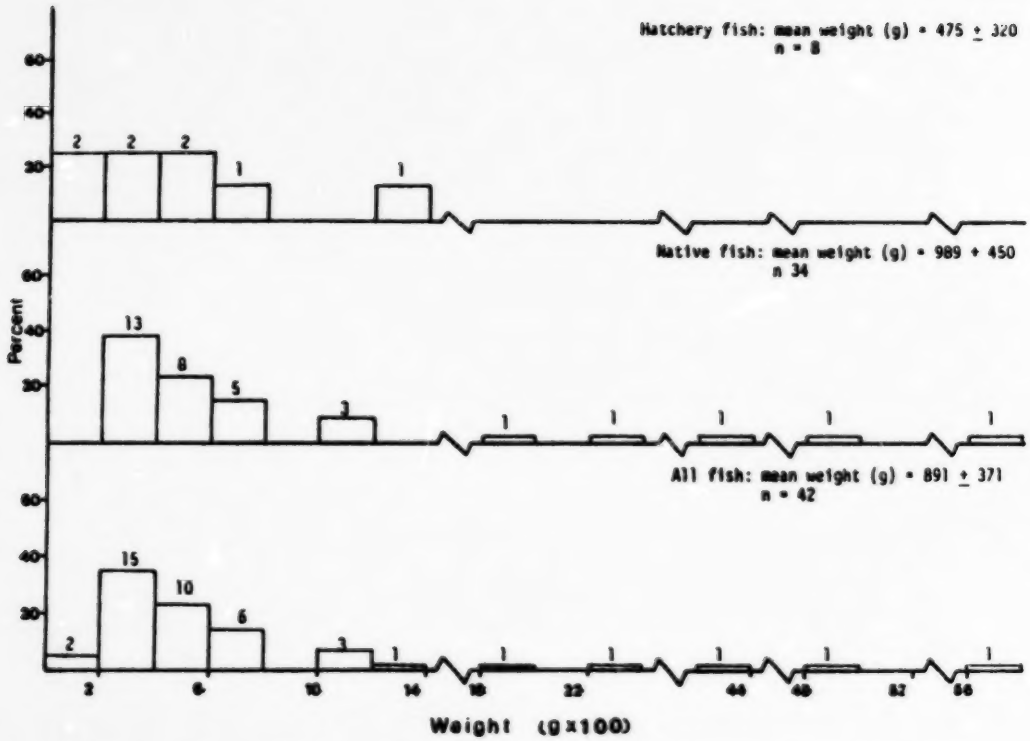

Hatchery fish: mean weight (g) = 475 ± 320
n = 8
Native fish: mean weight (g) = 989 ± 450
n 34
All fish: mean weight (g) = 891 ± 371
n = 42
Percent
Weight (g x100)

Figure 4.63 Weight distributions of lake trout sampled during the winter 1981 sport fishery on Devil Lake. Numbers over each bar indicate actual count frequencies.

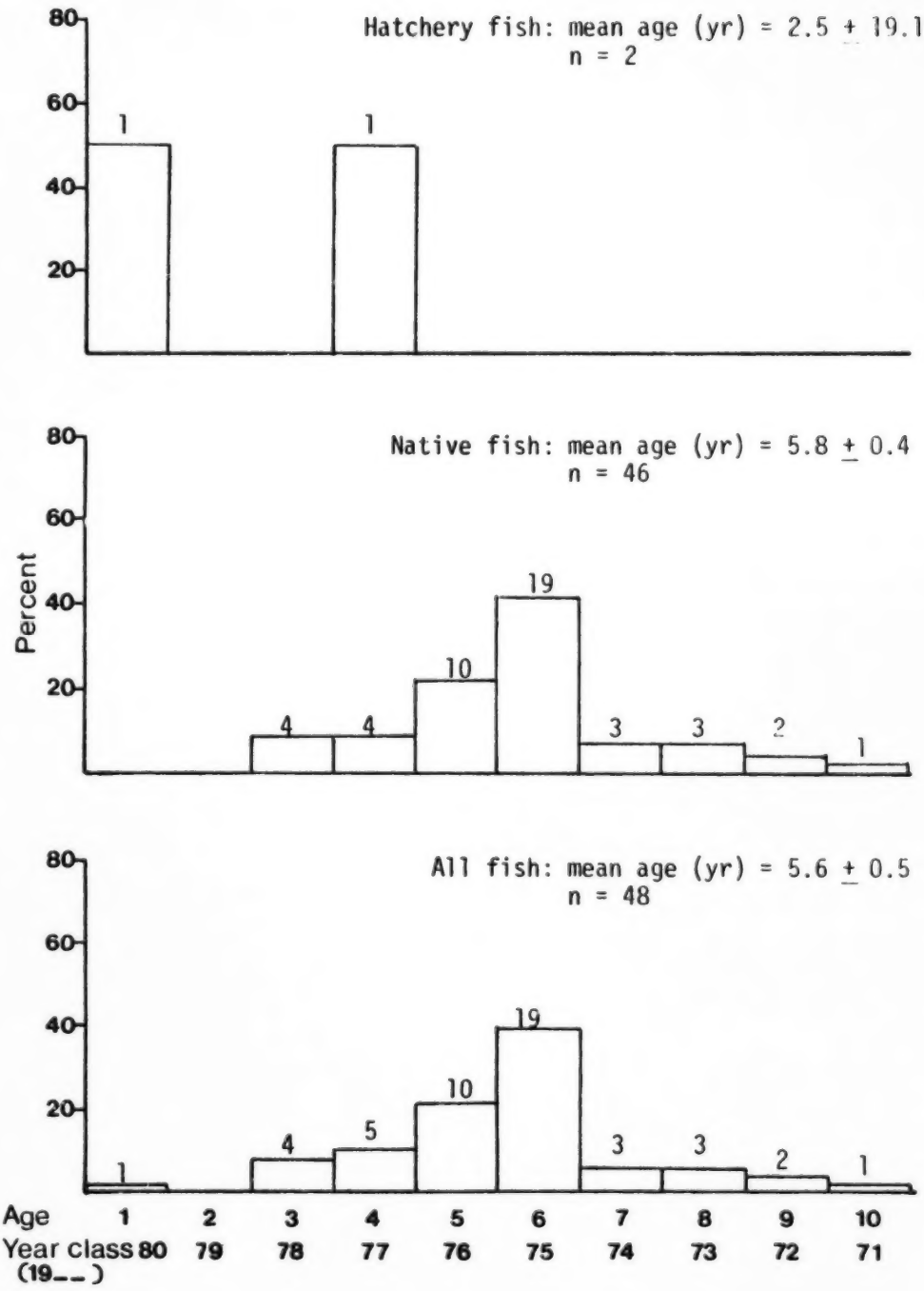


Figure 4.64 Age distributions of lake trout sampled during the summer 1981 sport fishery on Devil Lake. Numbers over each bar indicate actual count frequencies.

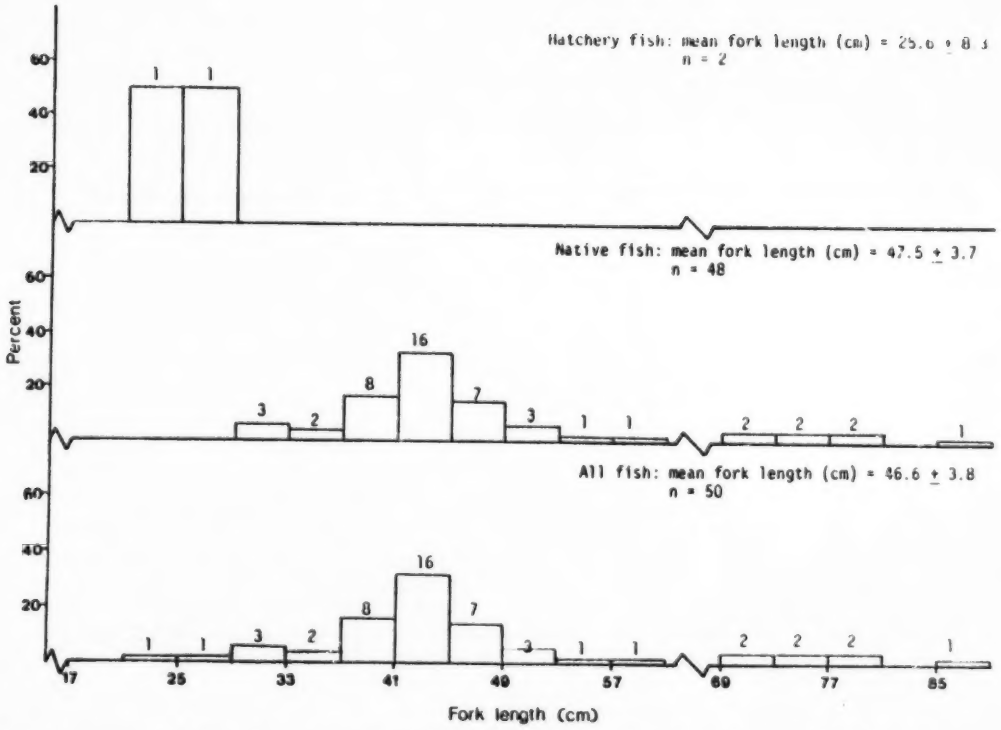


Figure 4.65 Fork length distributions of lake trout sampled during the 1981 summer fishery on Devil Lake. Numbers over each bar indicate actual count frequencies.

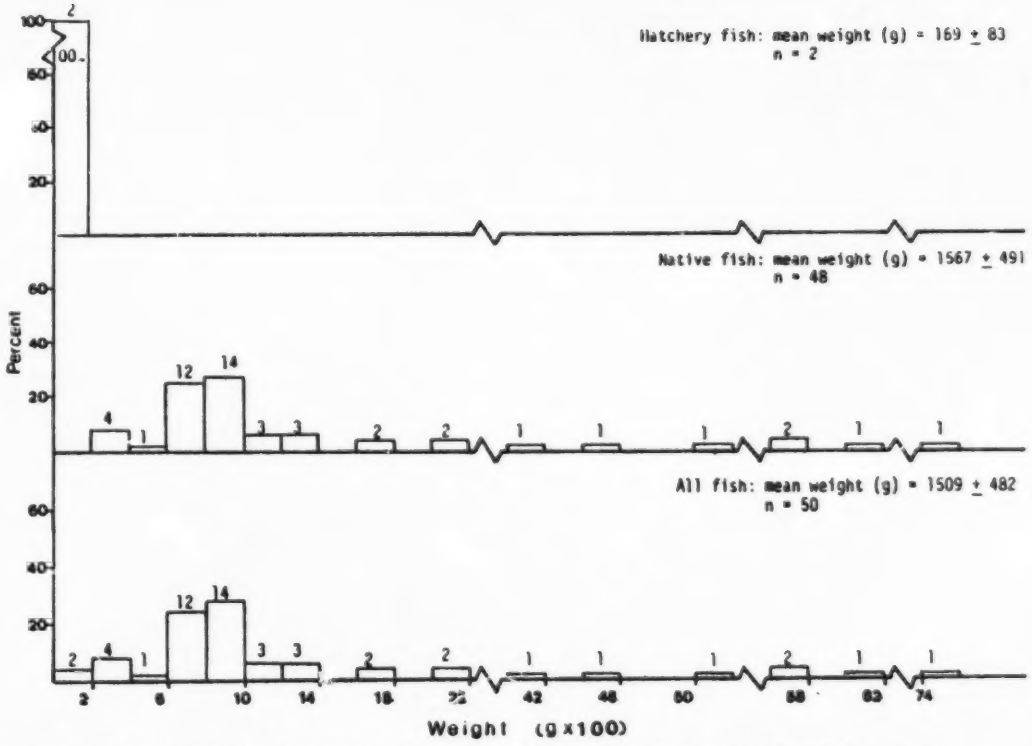

Hatchery fish: mean weight (g) = 169 ± 83
n = 2
Native fish: mean weight (g) = 1567 ± 491
n = 48
All fish: mean weight (g) = 1509 ± 482
n = 50
Percent
Weight (g x100)

Figure 4.66 Weight distributions of lake trout sampled during the 1981 summer fishery on Devil Lake.
Numbers over each bar indicate actual count frequencies.

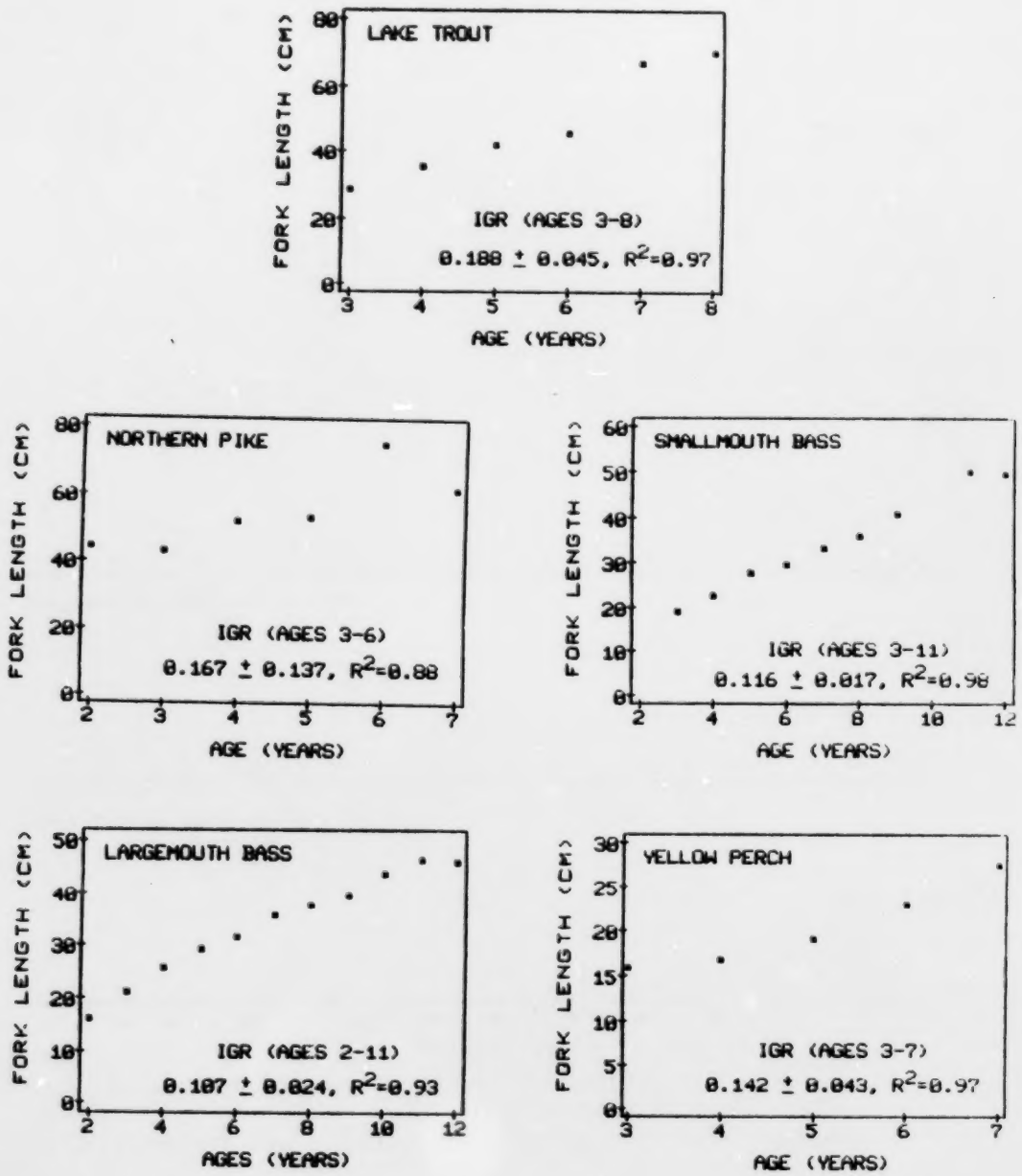


Fig. 4.67 Absolute growth rate of lake trout, northern pike, smallmouth bass, largemouth bass, and yellow perch sampled at Devil Lake, 1981. Lake trout were sampled during the winter 1981 creel census. The other target species were sampled during the index trapnetting, June 3-12, 1981. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

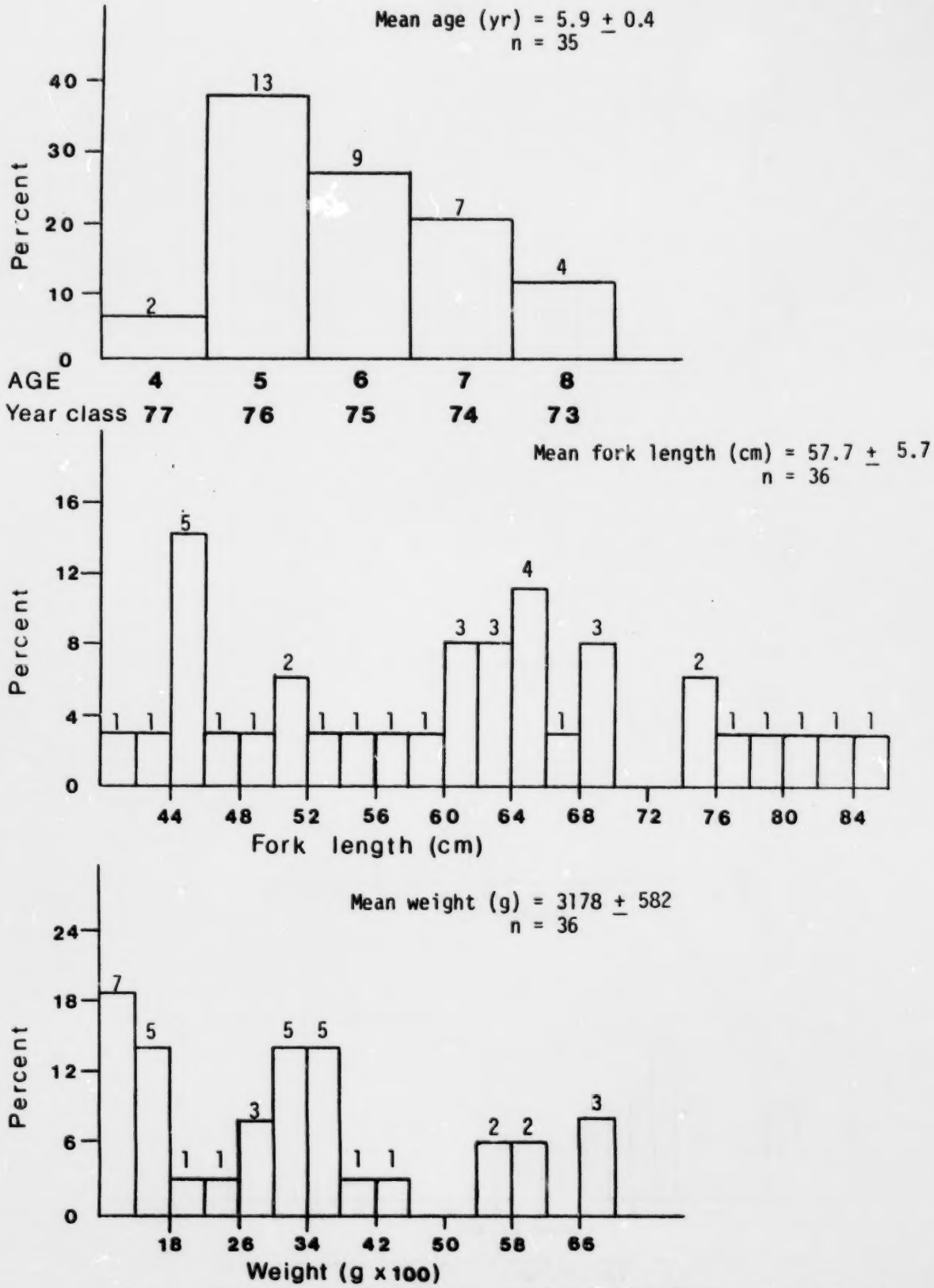
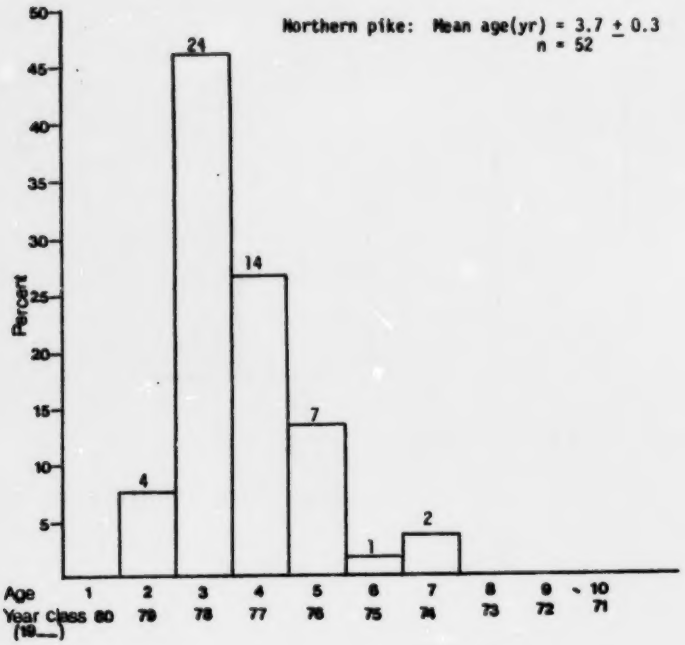
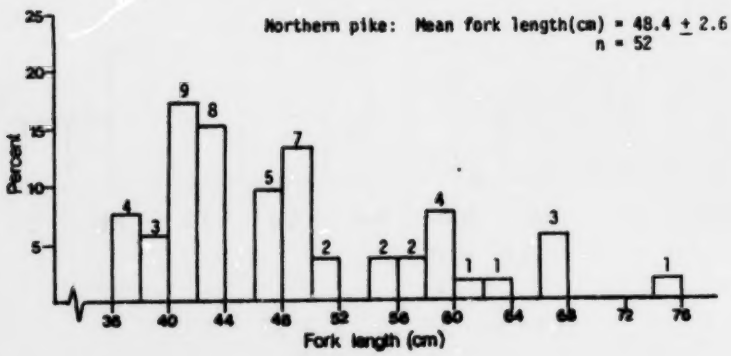

Mean age (yr) = 5.9 ± 0.4
n = 35
Percent
AGE
Year class
4 5 6 7 8
77 76 75 74 73
Mean fork length (cm) = 57.7 ± 5.7
n = 36
Fork length (cm)
Mean weight (g) = 3178 ± 582
n = 36
Weight (g x 100)

Figure 4.68 Age, fork length, and weight distributions of lake trout sampled during spawning assessment on Devil Lake, October 13-22, 1981. Numbers over each bar indicate actual count frequencies.





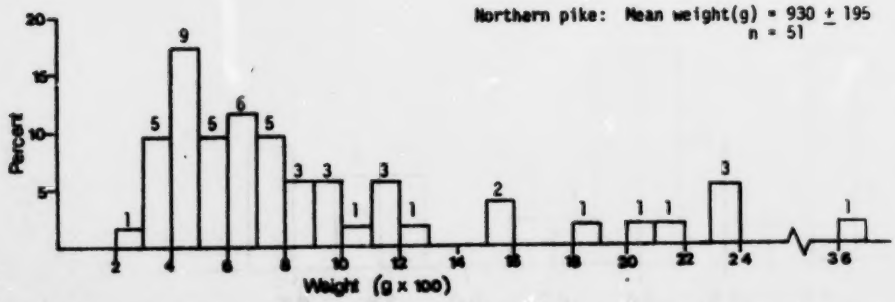
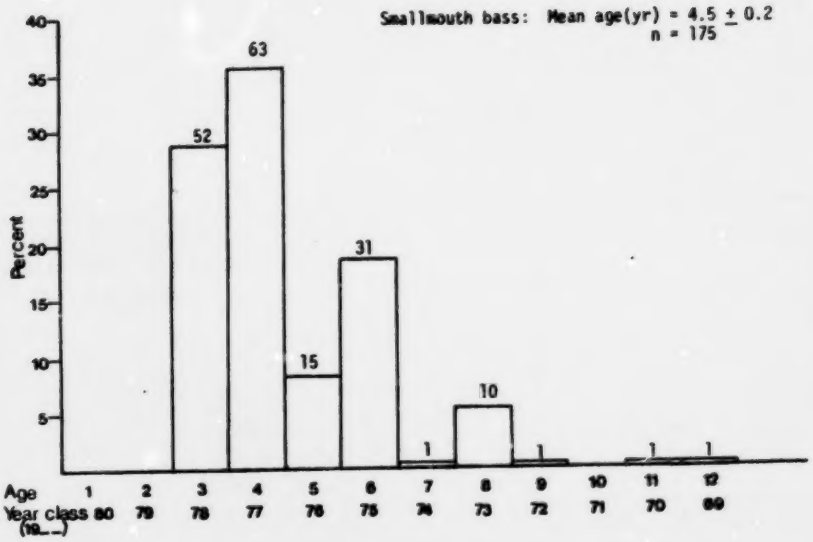
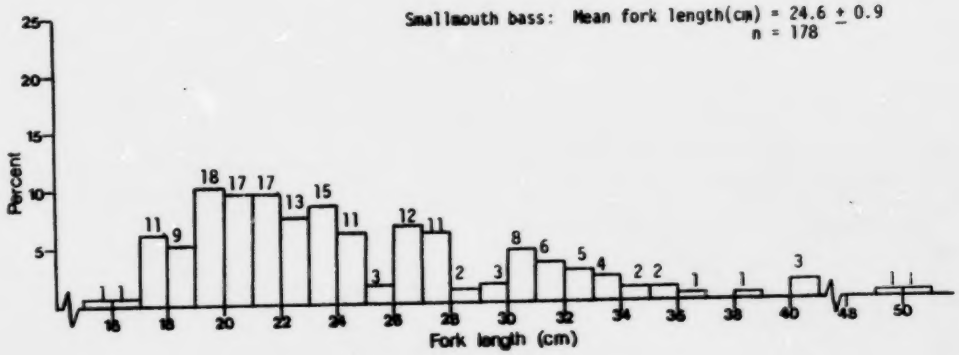


Figure 4.69 Age, fork length, and weight distributions of northern pike captured in trapnets on Devil Lake, June 3-12, 1981. Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.





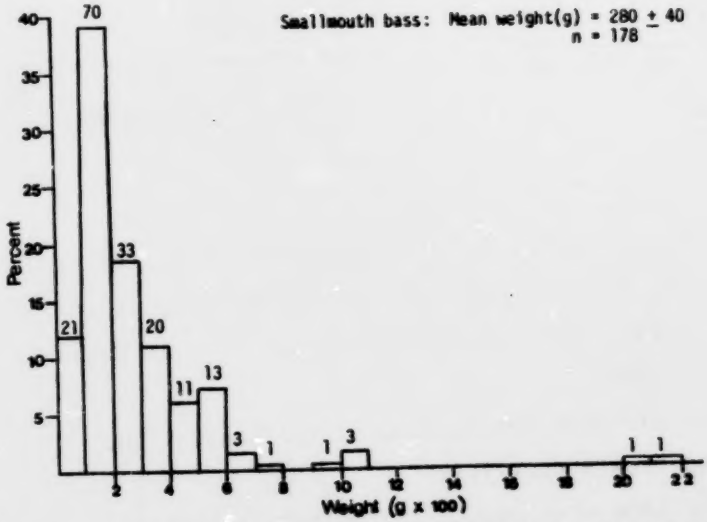


Figure 4.70 Age, fork length, and weight distributions of smallmouth bass captured in the trapnets on Devil Lake, June 3-12, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

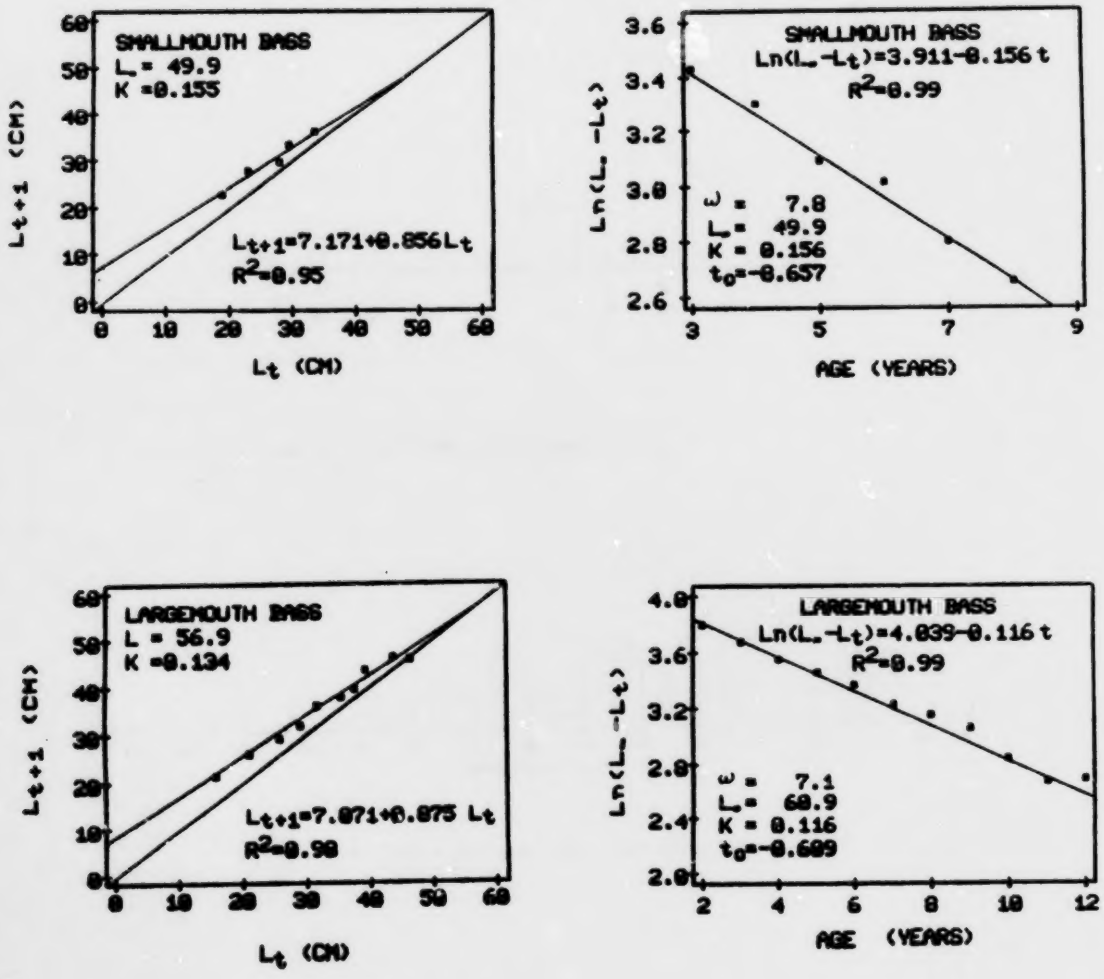


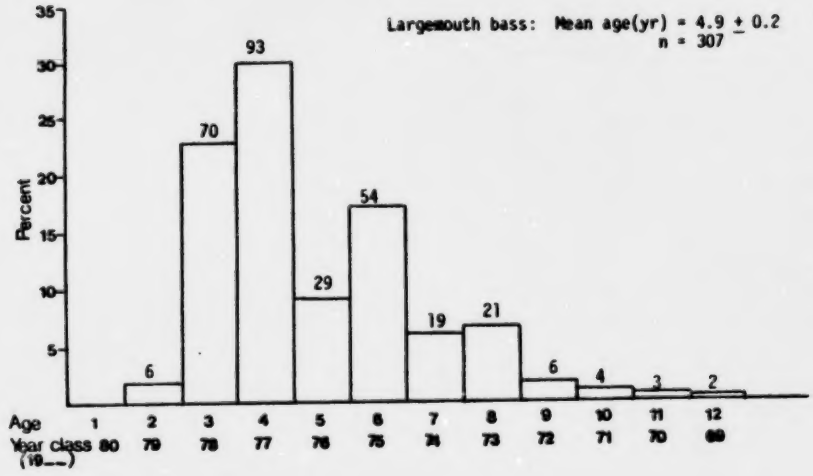
Figure 4.71 Walford, L_{t+1} against L_t, and von Bertalanffy, $Ln(L_\infty - L_t)$ against age, plots, based on mean lengths (cm) at age for smallmouth bass and largemouth bass captured in Devil Lake, June 3-12, 1981.

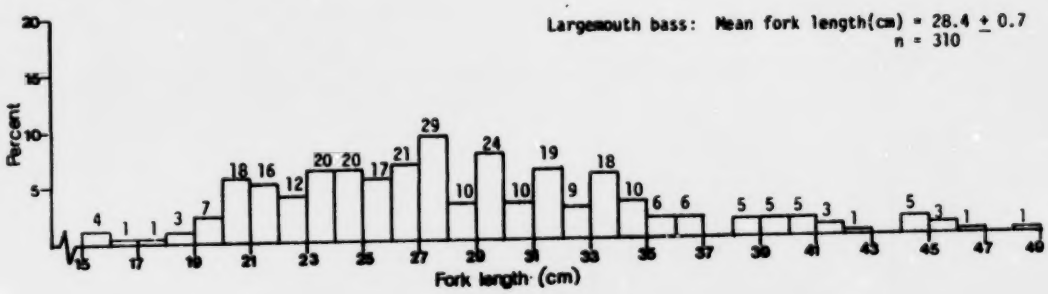
L_∞ is the ultimate length (cm) of the population.

K is the growth coefficient.

t_0 is the time when length is theoretically zero.

$\omega = K \times L_\infty$ (Galluci and Quinn 1979, based on linear regression).





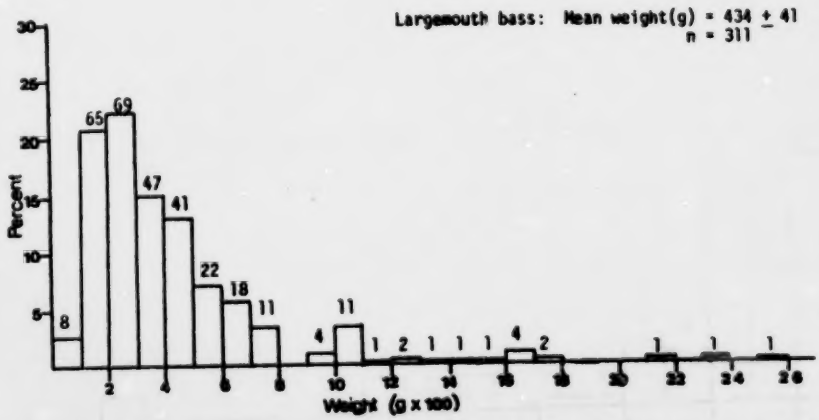


Figure 4.72 Age, fork length, and weight distributions of largemouth bass captured in the trapnets on Devil Lake, June 3-12, 1981.
Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

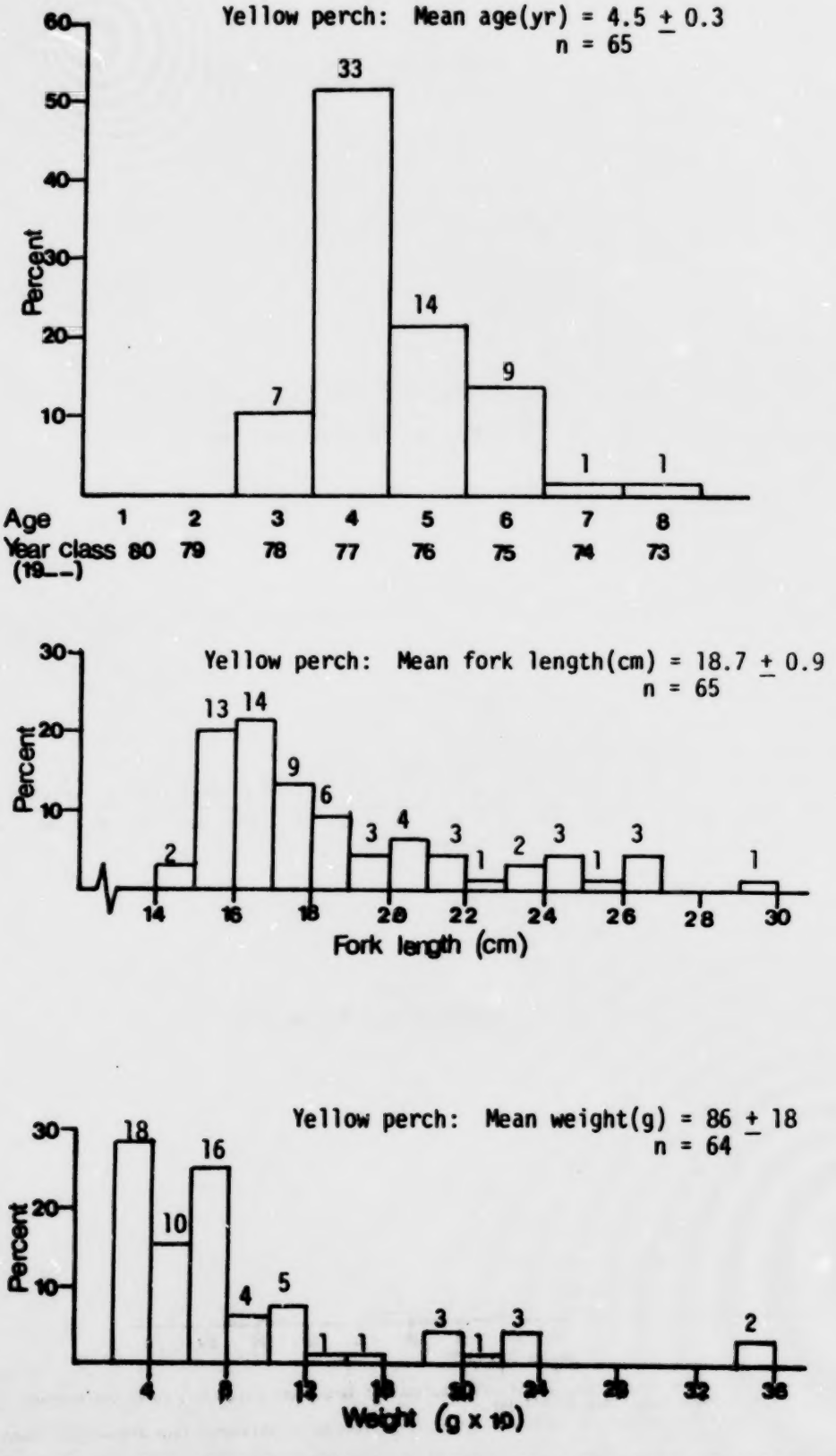

Yellow perch: Mean age(yr) = 4.5 ± 0.3
n = 65
Percent
Age
Year class (19__)
Yellow perch: Mean fork length(cm) = 18.7 ± 0.9
n = 65
Fork length (cm)
Yellow perch: Mean weight(g) = 86 ± 18
n = 64
Weight (g x 10)

Figure 4.73 Age, fork length, and weight distributions of yellow perch captured in the trapnets on Devil Lake, June 3-12, 1981. Numbers over each bar indicate actual (fork length) or estimated (age and weight) count frequencies.

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6. REFERENCES

Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsay, C.R. Robbins and W.B. Scott. 1970. A list of common and scientific names of fishes. Third Edition. Am. Fish. Soc. Special Publication No. 6. 150p.

Barnes, L.E., R.R. Claytor and N.G. MacLean. 1984. The sport fisheries of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 8. 124p.

Craig, J.F. and J.M. Fletcher. 1982. The variability in the catches of charr, Salvelinus alpinus L., and perch, Perca fluviatilus L., from multimesh gillnets. J. Fish. Biol. 20: 517-526.

Gale, G.E. and G.A. Goodchild. 1982. Review and reformulation of the relationship between standard conductance and total dissolved solids. Ont. Min. Nat. Res., Environmental Dynamics Section, Fisheries Branch. 41p. + app.

Galluci, V.F. and T.J. Quinn, II. 1979. Reparameterizing, fitting, and testing a simple growth model. Trans. Am. Fish. Soc. 108: 14:25.

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, Toronto, Canada. 257p.

Haedrich, R.L. 1975. Diversity and overlap as measures of environmental quality. Water Research 9: 945-952.

Hamley, J.M. 1975. Review of gillnet selectivity. J. Fish Res. Board Can. 32: 1943-1969.

Healey, M.C. 1978. The dynamics of exploited lake trout populations and implications for management. J. Wildl. Manage. 42: 307-328.

Kesteven G.L. (Ed.) 1960. Manual of field methods in fisheries biology. F.A.O. Manuals in Fisheries Sciences, No. 1. F.A.O., Rome. 152.

Laarman, P.W. and J.R. Ryckman. 1980. Size selectivity of trapnets for eight species of fish. Mich. Dept. Nat. Res., Research Report No. 1880. 15p.

Latta, W.C. 1959. Significance of trapnet selectivity in estimating fish population statistics. Pap. Mich. Acad. Sci. 44: 123-128.

MacLean, N.G. 1980. Lake trout spawning assessment field programme, fall 1980. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. File Report No. 11. 13p.

MacLean, N.G. J.P. Boraski and B.J. Munroe. 1985. Age verification of lake trout based on the examination of scales and pectoral fin rays. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. In preparation.

MacLean, N.G. and D.A Schlesinger. 1982. The sport fisheries of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 4. 117p.

MacLean, N.G. and W.G. Smith. 1981a. Five-year operational plan. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. File Report No. 4. 34p.

Margalef, D.R. 1968. Perspectives in Ecological Theory. Univ. of Chicago Press, Chicago Ill. 111p.

MacKay, H.H. 1963. Fishes of Ontario. Ontario Dept. Lands and Forests. Bryant Press Ltd., Toronto, Ontario. 300p.

Ontario Ministry of Natural Resources. 1981. Summary of the fishing regulations. Ont. Min. Nat. Res., Fisheries Branch 22p.

1982. Partitioning yields from the morphoedaphic index into individual species yields. Report of SPOF working group number twelve. Strategic Planning for Ontario Fisheries. Ont. Min. Nat. Res., Policy development. 71p.

1983. The identification of overexploitation. Report of SPOF working group number fifteeen. Strategic Planning for Ontario Fisheries. Ont. Min. Nat. Res., Policy development. 84p.

1984. The transfer, exchange and application of Fisheries Assessment Unit intelligence to District fisheries management. Report of SPOF working group number eighteen. Ont. Min. Nat. Res., Policy development. 55p.

Nichols, S. 1977. On the interpretation of principal components analysis in ecological contexts. Vegetatio 34: 191-197.

Pope, J.A., A.R. Margetts, J.M. Hamley, and E.F. Akyuz. 1975. Manual of methods for fish stock assessment. Part III. Selective of fishing gear. F.A.O. Fish. Tech. Pap. 41p. Rev. 1. 65p.

Ricker, W.E. 1969. Effects of size-selective mortality and sampling bias on estimates of growth, mortality, production

and yield. J. Fish. Res. Board Can. 26: 479-541.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin Fish. Res. Board Can. No.:191. 382p.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966p.

Smith, W.G. and N.G. MacLean. 1984. Water quality assessment of Big Clear, Big Rideau, Big Salmon, Charleston and Devil Lakes. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 5. 77p.

Sprules, W.G. 1977. Crustacean zooplankton communities as indicators of limnological conditions: an approach using principal component analysis. J. Fish. Res. Board. Can. 34: 962-975.

Steele, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistis. A Biometrical Approach. McGraw-Hill, Toronto, Ontario. 633p.

Tonn, W.M., J.J. Magnuson and A.M. Forbes. 1983. Community analysis in fishery management: An application with northern Wisconsin lakes. Trans. Am. Fish. Soc. 112: 368-377.

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